

The University of Chicago

THE GEOGRAPHIC STRUCTURE OF
THE VEGA DE VALENCIA

A PART OF A DISSERTATION SUBMITTED TO
THE FACULTY OF THE DIVISION OF THE
PHYSICAL SCIENCES IN CANDIDACY FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF GEOGRAPHY

1936

By
ALICE FOSTER

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FOREWORD

The following pages deal with an area covering some 1,100 square miles on the Mediterranean border of the Iberian Peninsula. The term Vega de Valencia is used to designate the lowland area together with its inhabitants, the human and physical components being associated in complex interrelations. The term is used by Valencian writers, but the extent of the area designated by the term varies with different authors. Sometimes it is restricted to the Turia delta and at others it is applied to the middle lobe of the Vega crescent. In view of this lack of uniformity and the apparent absence of any term customarily applied to the entire lowland considered in this study, I have taken the liberty of giving the term a somewhat broader application than it has in local use, extending it to include the lowlands about Castellón and Gandía.

In attempting an analysis of the Vega de Valencia, I have been concerned with areal characteristics, both functional and physical. Certain features of the geographic complex constitute a framework of structure that gives the Vega its areal individuality. There exists also an internal differentiation resulting in functional units, or areal forms. Other structures are part of the geographic set-up of Western Europe and tie the Vega into the life of the region. These findings are in harmony with the oft-quoted theory that a region possesses structures analogous to those of living organisms. An analysis of the facts secured through personal observation and a perusal of the available literature leads to the conviction that areal differentiation in the cultural features of the Vega de Valencia is a phenomenon gradually developed during a long period of occupancy.

During the progress of the work I benefited from the cooperation of many people. Miss Harriet Carter was with me in Spain during the summer of 1931 and contributed much to the success of the field season. The aid rendered by Valencia business men and by government officials both there and in Madrid is largely responsible for success in securing the necessary data. Of particu-

lar significance is the help given by the following men: D. Manuel Herrero de Egaña, agronomist at the head of the horticultural work in the experiment station at Burjasot; D. Vicente Llinares of Alcira and D. Emilio Mackintosh of Valencia, orange exporters and growers; D. Vicente Calvo-Acacio, Secretary Cámara Oficial Agrícola de Valencia; D. Antonio Lattur Cortés, Oficial Mayor del Archivo-Biblioteca del Excmo. Ayuntamiento de Valencia; D. Vicente Remolí Montalar, D. Joaquín Muñoz Royo, and D. Emilio Martínez Romero, Valencia exporters; and D. Henri L. Sacki, manufacturer of citrus products. The local representative of the Spanish tourish bureau (Patronato Nacional del Turismo) rendered valuable assistance in the matter of contacts with people able to give us the desired information. To all these men and to others whose names cannot be mentioned here I am deeply grateful for their unfailing courtesy and consideration. During the preparation of the manuscript help and encouragement have come from various people in the Department of Geography at the University of Chicago. Of great value were the discussions in Professor H. H. Barrows' seminar at a time when the work still was in a more or less exploratory stage. Exceedingly helpful also was the privilege of informal discussions at later times with various members of the staff regarding ideas and plans still in a formative state. Professor Charles C. Colby read the analytical outline and the first chapter at critical stages in the progress of the work, and the final revision of the manuscript was made in the light of searching criticism by Professor H. H. Barrows.

THE GEOGRAPHIC STRUCTURE OF THE VEGA DE VALENCIA

The Vega in Its Spanish Setting

- General nature of the area
- Place in a section across the peninsula
- The local setting

Evidences of High Productivity

- Density of population
- Estimated crop yields

The Geoponic Pattern of the Vega

- The major geoponic types
- The Alboraya Type
- The Liria Type
- The Sueca Type
- The Alcira Type
- Time element in areal differentiation

Commercial Orientation

- Commercial nature of agriculture
- Trade of major port
- Principal functions of minor ports
- Exports of agricultural products by land routes
- Balance of assets and liabilities for trade

Physical Elements of Geographic Structure

- Coastal position in western Mediterranean basin
- Lowland surface and sedimentary materials
- Fine-textured calcareous soils
- Hot summers and mild winters
- Scant and irregular rainfall
- Resources of stream water
- Ground-water resources

Stage of Geographic Development

- Utilization of available resources
- Administration of stream water
- Technique for conserving soil fertility
- Areal specialization
- Diversity of economic motive
- Stability of occupation pattern

The Vega in Its Spanish Setting

General nature of the area.--The Vega de Valencia (Fig.1)

challenges geographic interest as an area of intensive and highly diversified agriculture. The variety and abundance of its horticultural products distinguish it among Spanish agricultural areas. Its ancient fame is proclaimed by the horn of plenty on Valencian coins of the Roman period¹ and its continued fruitfulness is de-

¹Reference 11B, I, 336 f.

Footnote citations to authorities listed in the bibliog-

picted in eloquent descriptions written by foreign visitors at various times within the last century. Though its area is only a little more than 1,100 square miles, the Vega produces three-fourths of the Spanish orange and rice crops, nearly the whole of the peanut crop, and more than 90 per cent of the onions exported from the country; and it is an important source of wine for both domestic consumption and export. The landscape displays a compact occupation pattern, and the large population of the Vega gives the province of Valencia a high average density (Fig. 2). Lying at the foot of the main stream divide of the peninsula, the Vega faces the Mediterranean both topographically and culturally. Railway lines and highways focus on the principal port, and the inland market centers all lie within a few miles of the sea (Fig. 3). The long coast line and restricted width of the Vega emphasize the invitation of the sea, while the difficult mountain barrier on the west, together with the circuitous nature of the rail route to Madrid, discourages intercourse with the Meseta. Through Valencia and six other ports of lesser rank, the Vega receives incessant stimuli from the economic life of Western Europe, and the agricultural surplus moves principally by sea. The export list gives only a vague hint of the productivity and diversity of agriculture. The productivity of the soil reflects a rich endowment by nature but also bespeaks determined struggle against natural handicaps. Diversity is associated with a high degree of areal specialization.

The areal individuality of the Vega de Valencia is recognized even by the casual observer and becomes more and more evident as acquaintance with the area progresses. A careful analysis of available facts leads to the conclusion that individuality has been attained through evolutionary development involving both physical forces and human volition. Neighboring areas do not duplicate the complex of physical characteristics present in the Vega, nor do they draw upon exactly the same cultural heritage, hence there have been distinct trends in the utilization of natural resources. Contributing to the development of areal individuality, there has occurred a gradual evolution of functional divisions of area, each having special responsibilities in the life of the Vega as a whole. Effective utilization of resources is accomplished through intel-

raphy at the end of this study are made by number. Other authorities are cited in accordance with customary practices.

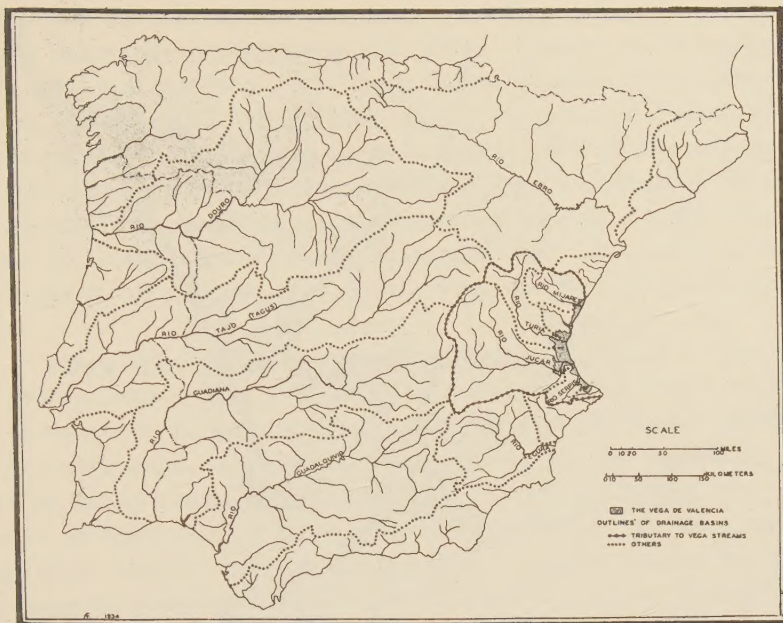


Fig. 1.--The Vega de Valencia in Spain.

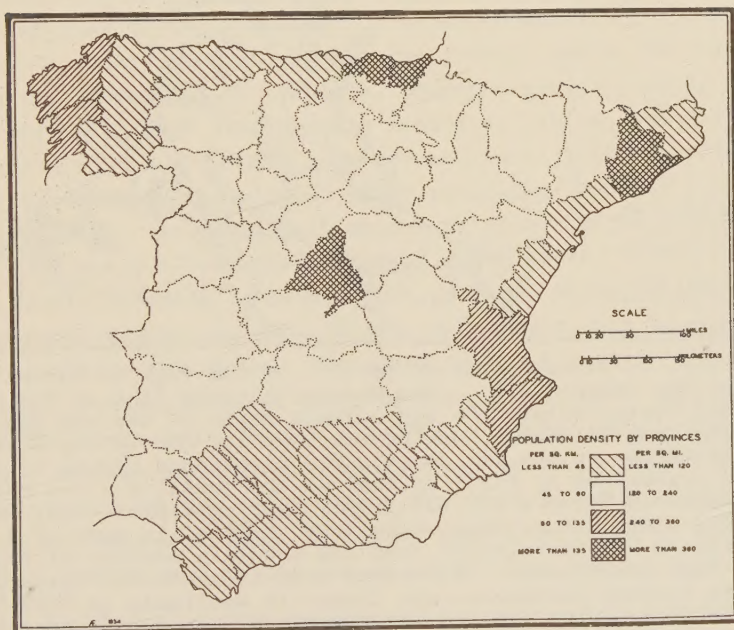


Fig. 2.--Average population density of Spanish provinces (Based on census for 1930, Reference 38).

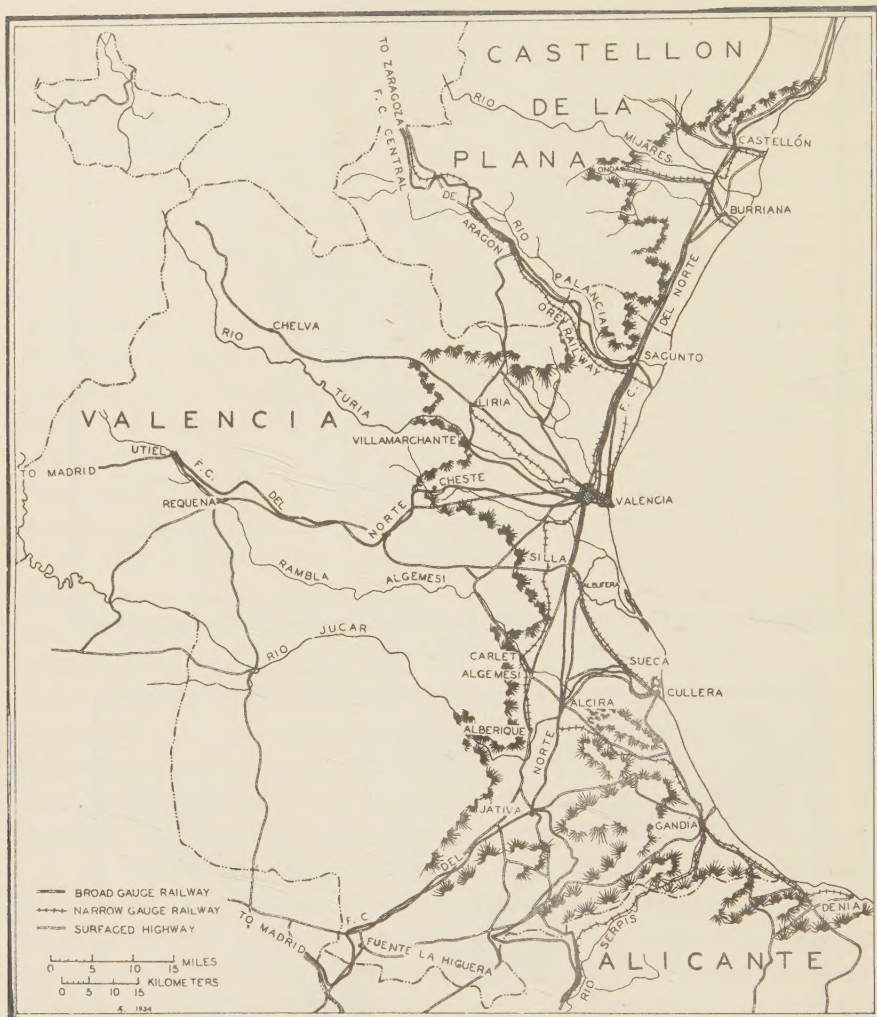


Fig. 3.--Transportation pattern of the Vega de Valencia (Based on Map reference 5). The Madrid-Valencia line of the Ferrocarril del Norte follows the approximate route of the old Camino Real south from Valencia, leaving the Vega via the valley of a stream tributary to the Rio Júcar. The circuitous nature of this route is emphasized by the fact that at the junction a few miles above Fuente la Higuera all but first-class passengers must change cars. The east-west railway which ends at Utiel is part of a projected direct Madrid-Valencia line the mountain section of which has not been constructed. Northward from Valencia the Ferrocarril del Norte reaches Barcelona, and thence it continues to Port Bou on the frontier. The line of the Ferrocarril de Aragón running northwest from Sagunto affords the shortest route to the western passes across the Pyrennees.

ligent effort, which draws upon a rich heritage of local experience and makes use of the permanent works of many preceding generations. While distinctly individual in its economic life, the Vega displays awareness of the outside world, and ties of commercial intercourse befit its nature as an integral part of Western Europe. This investigation seeks a recognition of the distinctive features that characterize the Vega as a geographic entity, of the internal structures concerned with areal functions, and of the external structures which tie the life of the Vega to that of the larger region.

Place in a section across the peninsula.---Seen at the end of a journey across the Iberian Peninsula, the exuberance of the Vega de Valencia is emphasized by sharpness of contrast. Landing at a Galician port, the traveler immediately is surrounded by evidences of human struggle with nature. Galicia is one of the few sections of Spain that have a rainfall sufficient for dependable agriculture without irrigation, but level land is scarce, and there apparently is a meager allotment of sunshine. Farms cluster on tiny deltas or alluvial fans and cling to the terraced slopes of fiord-like valleys. Vines are trained high on trellises; but at best, according to the statement of a native Galician, the wine is too sour to command a high price. The journey across the Meseta deepens the impression of struggle. Parched plains testify to a scanty rainfall, much of the grain land lies fallow, and the vines are trained on the ground to conserve moisture. Villages cling to the skirts of mesa-like ridges, where water for domestic purposes can be obtained. An occasional garden patch marks the presence of a well from which a horse-power noria¹ draws water. In the section of the Meseta known as La Mancha the landscape shows evidence of even greater aridity and much of the land serves only to furnish scanty pasturage for sheep. The climb down the eastern front of the Meseta gives only vague hints of what is to come. From time to time the train runs through a valley broad enough to hold small irrigated fields, and an occasional orange grove presages the subtropical nature of the Vega below. The first glimpse of the Vega, with its refreshing expanse of green, bursts upon the traveler with tantalizing briefness at the end of a mile-long tunnel above Fuente

¹The noria is a device that raises water by using the principle of the bucket chain. Its use is widespread in Spain.

la Higuera (Fig. 3), where the railway lies nearly 2,000 feet above sea level. Beyond this point the route threads its way among rocky slopes for some 35 miles before the evergreen floor of the Vega is reached. The density of crops and human habitations forms a sharp contrast to the landscape of the Meseta, and the broad expanse of level crop land is in marked contrast to conditions in neighboring sections of the Mediterranean littoral, where mountains extend to the shore and irrigable land is restricted to detached fragments separated by rugged ridges.

The local setting.--The Vega de Valencia is a crescent-shaped lowland about twenty miles wide in its central portion. A hundred-mile line of Mediterranean shore forms the shorter arc of the crescent, while the mountainous border of the Spanish Meseta bounds the area on the west. The greater portion of the Vega lies within the province of Valencia, but the northern part reaches about 28 miles into Castellon de la Plana and the southern horn of the crescent extends some ten miles into Alicante. The jagged contour of the escarpment makes the western boundary of the crescent very irregular. Mountain spurs reach almost to the shore and divide the crescent into three unequal lobes, the northern, middle, and southern lobes containing about 20, 70, and 10 per cent, respectively, of the total area. Each lobe focuses commercially on a city strategically placed near the center of its coast. Though situated two to four miles inland, these cities carry on trade by sea; and commercial suburbs, in each case known as "El Grao," have grown up on the shore. The middle lobe, being also the largest, logically contains the principal city and chief port. Castellón, some 40 miles northeast of Valencia, dominates the lobe second in size; and Gandía, about the same distance to the southeast, forms the principal commercial center of the smallest lobe.

The most productive portion of the Vega forms an inner crescent bordering the Mediterranean and lying mainly at altitudes of less than a hundred feet (Fig. 4). The recurrence of the term huerta in the names applied to several divisions of this area indicates the garden-like nature of the cultivated land. Huerta, as used in Valencia, means land devoted primarily to the production of garden vegetables and small fruits, though cereals, feed crops, and fruit trees all may have a place in the agricultural system. The heart of each lobe is an intensively-farmed deltaic area surrounding the principal city and supplied with water from the stream

which built the delta. The middle lobe consists of a deltaic doublet whose margins are extended by the alluvial deposits of several short streams. The sedimentary deposits of the Turia and Júcar rivers correspond roughly to the areas known as the Huerta de Valencia and the Ribera del Júcar. The Huerta de Játiva forms a southern expansion of the Ribera, occupying the open valley where the Montesa and Albaida rivers unite on their way to join the Júcar. The Huerta de Sagunto, at the northern margin of the lobe, has as its foundation the delta of the short Río Palancia. La Plana, the heart of the northern lobe, consists of the Mijares delta, together with the alluvial deposits of several short streams and a belt of reclaimed coastal marshes. The Huerta de Gandía is more nearly tropical than any other section of the Vega. Its garden-like farms occupy the alluvial deposits of several minor streams, the largest of which is the Río Serpis, or Alcoy. The three lobes are connected by a narrow band of irrigated lowland stretching along the shore.

Between the inner crescent and the mountains lies an irregular belt of somewhat higher land with a rolling or hilly surface and scanty water resources. In this belt, agriculture under dry-farming methods has reached a high state of development. At the north and the south, the escarpment which forms the border of the Meseta presses close to the coast, and the deltaic plains are separated from the mountains by a narrow fringe of foothills and piedmont deposits. In the middle of the crescent, the escarpment recedes from the coast, leaving a broad embayment in which lie the Campo de Liria and the Llano de Cuart. These plains stretch inland from the belt of low hills that bounds the Huerta de Valencia on the west. They have elevations somewhat above 100 feet on the east and rise to altitudes of 400 to 500 feet at the foot of the escarpment.

Evidences of High Productivity

Density of population.--Only a richly productive area could support an agricultural population as dense as that which occupies the Vega de Valencia. In population density the province of Valencia ranks sixth among the provinces of Spain, being surpassed by Barcelona, Madrid, the coal and iron producing provinces on the Biscay coast, and the crowded Galician provinces (Fig. 2). Its average density is nearly double that of Spain, which contains 16 per cent more people per square mile than the section of the United

States designated in census statistics the East North Central States. However, the density of population is much higher in the Vega than in the rest of the province (Fig. 5). The census divisions which lie wholly or mainly within the Vega contain more than a million people,¹ an average of 704 per square mile. This density exceeds that of Rhode Island by a little more than 9 per cent. Over the Vega surface are dotted cities, rural villages, and hamlets to the number of about 500. In the intensively farmed deltaic sections human habitations cluster closer than elsewhere, and in the heart of both the Huerta de Valencia and the Huerta de Gandía the population density of rural areas exceeds 2,500 per square mile.² In portions of the outer crescent which possess water supplies too scant to irrigate more than a small part of the land, settlements are more scattered; but in few of the census divisions does the average density fall below 100 per square mile. Directly or indirectly, most of the people depend for their living upon the utilization of soil resources. This fact was acknowledged in a graceful manner by the city of Valencia in the summer of 1931 through the unveiling of a statue dedicated to the farmers of the surrounding area. Sixty per cent of the working population (excluding those in domestic service) of the provinces of Valencia, Castellón and Alicante are engaged in agriculture,³ while the manufactural and commercial industries of the cities to a large degree are concerned with the products of the soil or the needs of agriculture.

Estimated crop yields.--The cultivated land of the Vega de Valencia yields high returns even for a region of intensive agriculture. Local authorities claim world leadership for the Vega in the yield of oranges and rice per unit area, and statistics lend some support to the claim. The Spanish orange crop of the later

¹Based on figures for the 1930 census, Reference 38.

²Based on total populations for census divisions outside the principal city of the Huerta. Spanish census returns are given only for political divisions, the smallest areal unit being the municipal término, or the area under the jurisdiction of an ayuntamiento (municipal council). All the inhabitants of a término may be concentrated in one village or town, but in many of the términos there are other population nuclei and in certain sections there are also scattered houses. Thus the returns do not distinguish between urban and rural population.

³Based on census data for 1920, Reference 42, 1928, pp. 16-17.

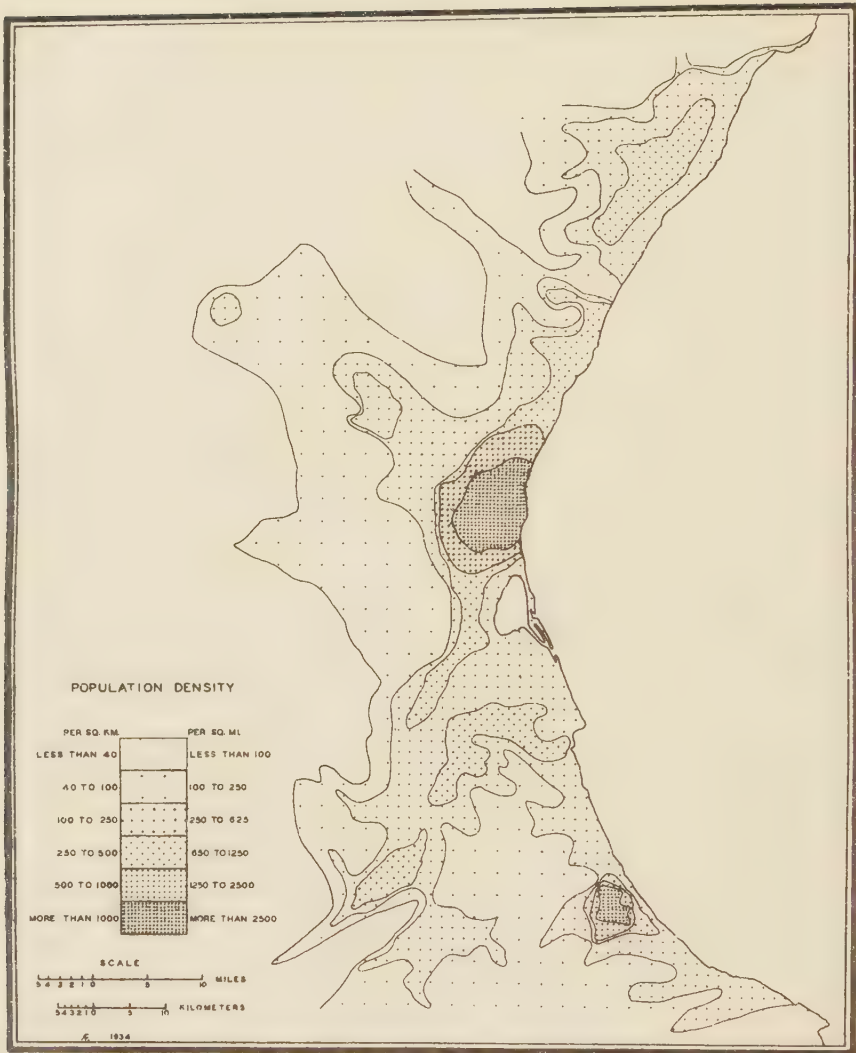


Fig. 5.--Distribution of population in the Vega de Valencia (Based on census data for 1930, Reference 38). Densities were computed for municipal términos, which form the smallest census divisions. Urban and rural populations are not distinguished in the census returns, hence in the vicinity of the larger cities the position of the isopleths is determined by the densities of municipal términos other than those of the principal cities. Computations were based on areas determined by planimeter measurements, except for términos in Alicante, areas for these términos being given in Reference 11C.

1920's was nearly equal to that of the United States, though the area devoted to orange groves was less than half as great (Fig. 6).

Producing Country	Orange Area	Metric Tons Produced	
	Hectares	Total	Per Ha.
Spain	56,921	1,117,694	19.8
United States	131,809	1,248,342	9.5
Italy (all citrus fruits, including mixed cultures)	111,901	702,182	6.3
Japan	33,582	318,266	9.5
Australia	14,107	64,212	4.6
South Africa	7,678	24,500	3.2

Fig. 6.--Average orange crop of principal producing countries for the five year period 1924-25 to 1928-29 (Computed from data in Annuaire International de Statistique Agricole, 1932-33).

In rice acreage Spain is surpassed by 22 countries, but the Spanish yield per acre exceeds that of any other country for which the International Institute of Agriculture publishes statistics.¹ The Vega de Valencia contains the principal producing districts for both these crops, and the average yield for the provinces of Valencia, Castellón, and Alicante exceeds that for Spain. The production of garden fruits and vegetables in the Vega employs land roughly equal in extent to that of the orange groves. Onions and early potatoes receive much attention. In 1929 onions occupied 9,500 hectares in the province of Valencia and irrigated potatoes 5,500 hectares (23,475 and 13,591 acres, respectively), and the average yield of these two crops was estimated at 300 and 280 metric hundredweight per hectare (470 and 439 bushels per acre) respectively.²

Estimates of crop values emphasize still further the high returns obtained from Vega land. According to official estimates, the average annual value of crops grown in the province of Valencia in the five-year period ending with 1928 was equal to 1,147 pesetas per hectare (nearly \$90 per acre, using gold value of peseta and former gold value of dollar in reductions) for all cultivated land

¹International Institute of Agriculture, Annuaire international de statistique agricole: 1932-33 (Rome, 1933), pp. 190-93.

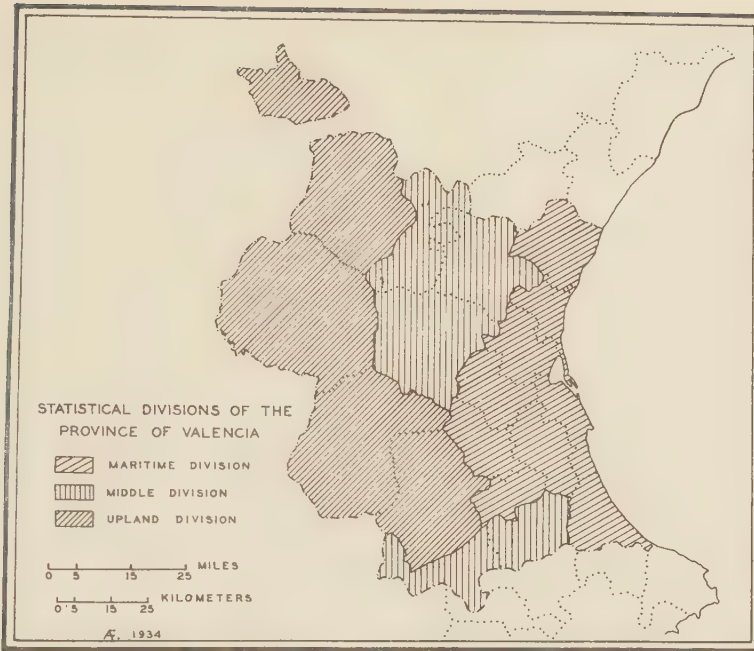
²Reference 46, 1929, p. 10.

in the province.¹ This average includes both irrigated and unirrigated crops, which differ greatly both in distribution and in yield. The contrast in distribution is exemplified by the commercial crops listed in Figure 7. Three divisions of the province of Valencia are recognized for statistical purposes,² nearly all the Maritime Division and probably half the Middle Division lying in the Vega. Onions and potatoes, typical irrigated crops, are grown mainly in the two eastern divisions and receive little attention in the Upland Division. Olives and grapes, grown without irrigation, rank as major crops in the western part of the province but have a minor place in the Maritime Division. The contrast is even more marked in the case of the orange, whose distribution is restricted both by its water requirements and by its sensitiveness to frost. It occupies very little land outside the Maritime Division. That the annual returns per unit area from Vega land exceed the average for the province is implied in the distribution of these two types of crops. During the period under discussion two-thirds of the total crop value of the province was accounted for by irrigated crops, though these crops occupied only 30 per cent of the cultivated land. In value per acre, only two of the principal irrigated crops fell below the average for all crops, and only one of the unirrigated crops exceeded that average (Fig. 8). Values of individual crops do not give a full idea of the productivity of land in the Vega de Valencia, for much of the land devoted to vegetables and garden fruits yields more than one crop each year.

The high returns obtained from the agricultural land in the Vega cannot be attributed wholly to the nature of the area, since favoring conditions are associated with natural handicaps. Rich soils yield abundant crops in spite of a scanty and irregular rainfall. Agriculture which assumes the existence of a continuous growing season faces the hazard of occasional frost. Streams furnish water for irrigation, but they are characterized by small size and widely fluctuating volume, making water-scarcity an ever-present handicap. Surface features and stream pattern make water accessible on a series of deltaic plains but place stupendous difficulties in the way of providing adequate storage facilities. Un-

¹Reference 29, pp. 9, 23.

²Reference 29, pp. 11, 13, 14, 16.



Crop	Total for Province	Distribution of Acreage by Statistical Divisions		
	Acres	Upland Division	Middle Division	Maritime Division
Olives.....	100,013	%	%	%
Grapes.....	256,988	35	40	25
Onions.....	23,080	56	39	5
Irrigated potatoes.	13,096	4	49	47
Rice.....	82,039	4	7	89
Oranges*	75,367	0.1	0.9	99
		13		87

*Note: The distribution figures for oranges are not quite comparable, since a slightly different grouping of civil units is used in the published statistics, thus listing in the Middle Division two rather important orange-producing areas which for the other crops are considered as belonging to the Maritime Division.

Fig. 7.--Distribution of typical crops in the province of Valencia (Based on averages for the five-year period 1924-28, as given in Reference 29, pp. 11-18).

derground stores of water, apparently of generous extent, permit the expansion of the irrigated acreage, but the utilization of

	Crop Area	Crop Value per Acre	
	Acres	Pesetas	Dollars
All Crops.....	1,207,359	464	89.55
Irrigated Crops			
Oranges and mandarins.....	80,897	1,754	338.52
Rice.....	82,039	894	172.54
Wheat.....	31,699	594	114.64
Corn.....	21,004	428	82.60
Onions.....	23,080	1,431	276.18
Peanuts.....	22,239	998	192.61
Beans.....	18,533	990	191.07
Potatoes.....	13,097	1,487	286.99
Alfalfa.....	12,355	583	112.52
Barley.....	8,649	342	66.01
Melons.....	7,413	2,671	515.50
Tomatoes.....	7,413	1,821	351.45
Carrots.....	4,942	971	187.45
Cabbage, lettuce, endive, cauliflower, and spinach...	3,978	1,401	270.39
Habas (<i>Faba vulgaris</i>) for seed.....	3,212	621	119.85
Peppers.....	3,707	680	131.54
Unirrigated Crops			
Grapes, including young vines	256,682	143	27.60
Algarrobos, including scattered trees.....	168,031	218	42.17
Olives.....	98,842	216	41.69
Wheat.....	63,110	194	37.44
Barley.....	56,498	162	31.27
Almonds, including scattered trees.....	9,758	662	127.77

Fig. 8.--Value per acre of major crops of province of Valencia (Computed from averages for the five-year period 1924-28, as given in Reference 29, pp. 10-20).

these resources involves large capital expenditures and high operating costs. Success in utilizing natural advantages and in meeting the challenge of hampering circumstances indicates an advanced stage of geographic development.

The Geoponic Pattern of the Vega

The success of commercial agriculture in the Vega de Valencia indicates a high degree of harmony with natural conditions on the one hand and with commercial opportunity on the other. In the attainment of such harmony the general trend of Mediterranean agri-

culture has been followed, but regional individuality has been maintained and much internal variety developed. Throughout the Vega there is a fair degree of uniformity in those broad phases of the natural environment which determine the range of choice in crop production, but differences exist in elevation, exposure, and soil quality, together with significant contrasts in the amount and nature of water resources. Crop distributions hint at these underlying natural conditions but also reflect the areal pattern of such non-material features as land tenure, water rights, and administrative practices. To designate in its areal spread this complex of interrelated features, both natural and cultural, both visible and abstract, the term geoponic pattern is used here.

The major geoponic types.--The characteristic geoponic pattern of the Vega is formed by a series of areal units, each representing the extent of a particular geographic complex (Fig. 9). While variety in detail is manifold, the geoponic units fall into four major groups, or types, differing in their crop combinations and in the nature of the terrain occupied. These four types, each named for a locality where the type is well developed, are the Alboraya Type, the Liria Type, the Sueca Type, and the Alcira Type. Since minor details of both natural conditions and cultural heritage differ from section to section of the Vega, the areal units within each type have their own individuality; and since natural conditions offer a wide range of choice, details are not identical throughout even a specific unit. Moreover, the wide range of choice permits a shifting of detail on individual sites from year to year as changes in market conditions occur.

The Alboraya Type.--The units of the Alboraya Type display highly intensive utilization of favorable sites. They are characterized by a diversity of commercial, provision, and forage crops grown on low-lying but well-drained alluvial tracts with clay soil. Water for irrigation is derived principally from streams by means of long-established canal systems under community administration. However, water for some tracts is drawn by norias from shallow wells. The areas of this type are known locally as huertas - literally, gardens. Occupance is nearly complete, both as to area utilized and as to season of utilization. Prevailingly the fields bear a sequence of short-season crops which includes cereals, legumes, and truck crops. Diversity, rather than any particular crop, characterizes the rural landscape, and it seems highly probable

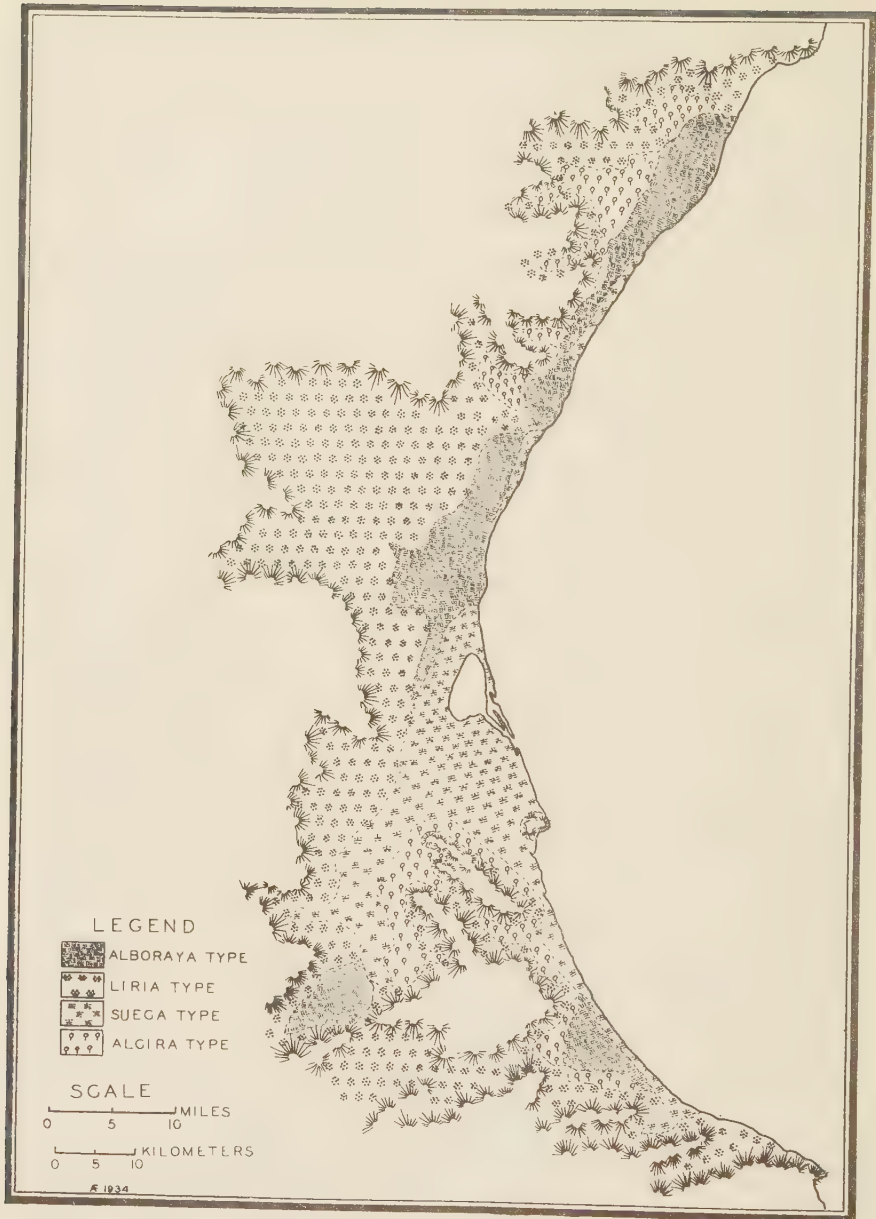


Fig. 9.--Geponic pattern of the Vega de Valencia. (Based on field observations, generalizations by local specialists, descriptions of surface and soil in various geological works, maps of irrigation systems, and non-statistical crop distributions given in Reference 11 and Reference 19. Exactness of boundaries for the various areal units is not claimed.)

that the agriculture of this type is the climax for the Vega.

Five major units of the Alboraya Type appear within the Vega. Four of the units (La Plana, the Huerta de Sagunto, the Huerta de Valencia, and the Huerta de Gandía) occupy coastal positions, diverting water from the Mijares, Palancia, Turia, and Serpis rivers to irrigate deltaic land (Fig. 4). The principal commercial center of each of these units is a port, though the migration of the shore line during the long centuries since the founding of the cities has left them several miles inland. The Huerta de Játiva occupies an inland position, drawing water from the Río Júcar and several tributary streams.

The Liria Type.--The range of choice in agricultural production is narrower in the Liria Type than in the other geponic types of the Vega, with the exception of certain areas of the Sueca Type. Because of the scantiness of water resources, only a small fraction of the tilled acreage can be irrigated. The greater part of the agricultural land is devoted to drought-resistant perennials grown under dry-farming methods, the principal commercial crops being the vine, the olive, the algarrobo (a variety of locust), and in some sections the almond. The soil in most areas of the Liria Type is extremely congenial to these crops because of its high lime content, but the erratic distribution of rainfall makes the yield very irregular. Considerable tracts with rough surface or with soil poor in water-retention remain uncultivated, but in most cases these tracts furnish pasturage. Human habitations cluster at points where springs or small streams furnish water for domestic purposes and for irrigating small tracts of huerta land. Without the comparatively regular yield of food and feed crops supplied by the irrigated tracts, life in settled communities would have been impossible during the long centuries of local self-sufficiency. The productive capacity of the land probably owes less to human modification of the natural landscape than in the other types.

The Sueca Type.--The Sueca Type is characterized by the utilization of terrain in transition from submergence to adequate drainage. The principal areal unit covers the Ribera del Júcar, and narrow strips fringe the shore both north and south of the major area. The typical soils are heavy clays with mucky characteristics and a high lime content, but they merge into the beach sands of the Mediterranean shore, and a belt on the western margin

of the Ribera Baja has reddish soils with a relatively high proportion of sand. The distinctive commercial crop is rice. According to the stage of reclamation, this crop is grown under a monocultural plan, alternates with a winter crop of legumes, or forms one member of a diversified crop combination. On the northern margin of the Ribera, the well-drained phase of the Sueca Type merges into the Huerta de Valencia with no definite boundary.

The Alcira Type.--The Alcira Type represents geographic rejuvenation of occupied terrain which until relatively recent times lacked available water for irrigation. It consists of orange-growing piedmont plains lying at the foot of the Corbera-Gandía mountain group (Fig. 4) and those of the ranges which border the Huerta de Sagunto and La Plana. Nowhere does it extend inland more than about fifteen miles. Being absent from the middle portion of the Vega crescent, it is separated into two major units, each of which is somewhat divided. The piedmont plains, lying above the level of the principal canal systems, were relatively low in productive capacity until technological advances made their ground-water resources accessible. At present they are the preferred areas for citrus culture, for the reddish piedmont soils are somewhat more porous than the soils of the huertas, and in many localities the piedmont slopes afford a considerable degree of frost protection through air drainage. The Alcira Type accounts for the bulk of the Valencia orange crop. It shows its relative geographic youth by a marked tendency to areal expansion, a greater degree of dependence on foreign markets than is characteristic of the Vega as a whole, and relatively little diversity in the crops grown. Scattered residences are more common than elsewhere in the Vega.

Time element in areal differentiation.--It seems probable that the Vega de Valencia has witnessed the full span of geographic evolution, from primitive exploitation of wild life and rudimentary agriculture to the present specialized utilization of diversified resources. Records are too fragmentary to reveal in detail the nature and duration of the various geographic stages, but the available evidence indicates that the geponic types have emerged at different times within the long period of human occupancy. The existence of a Stone Age site on the upland adjacent to the Vega indicates the presence of man in the general area at a very early period, probably about the close of the fourth glaciation in

Europe. The content of shell heaps and the presence of microlithic flints with blades as fine as needles indicate for this early period a kinship of culture with that of northern Africa, where increasing aridity was accompanied by a growing scarcity of game.¹ Acquaintance with the olive and its oil was an early acquisition, and there is historical reference to olive groves and a temple dedicated to Pallas in the vicinity of Valencia in the period of Greek colonization.² In the Roman period important irrigation works were established and many new crops introduced. The list of crops known to have been cultivated at that time includes many of the typical huerta cultures. Commercial agriculture became important and the vineyards of Liria produced for the Roman wine trade.³ Thus it seems probable that the Alboraya and Liria types had taken shape before the end of the Roman period, the former supplying the local requirements of communities engaged in growing commercial crops on unirrigated land. The Sueca Type seems to have emerged within the period of Moslem occupation. Rice culture and the reclamation of marsh land were practiced, the principal population nuclei had been established, the framework of the present irrigation systems had been laid out, and the orange tree had become a member of the huerta crop combination before the end of the period. Trade was turned from the sea to the interior of the peninsula, for the Moors prohibited the export of agricultural products.⁴ In order to make the surplus of the Vega available in other parts of the peninsula, additions were made to the road pattern. Whereas Roman roads had emphasized contact with the sea, Moorish additions to the highway network were designed to facilitate intercourse with the Meseta. The Alcira Type is young in years as well as in geographic characteristics. It dates from the latter half of the 18th century, and its development is in harmony with the commercial structure of the modern world. Its areal expansion has been accomplished mainly at the expense of the Liria Type. Geographic evolution in the Vega has not ceased. Minor changes in the geponic boundaries take place from time to time, and changes of considerable importance in the cultural landscape are projected for the future.

¹Henry Fairfield Osborn, Men of the Old Stone Age (3d.ed.; New York: Charles Scribner's Sons, 1918), pp. 514-25.

²Reference 11B, I, 60, 332.

³Reference 11A, p. 772, n. 6; Reference 11D, pp. 273-74.

⁴Reference 11D, pp. 182, 278.

Commercial Orientation

Commercial nature of agriculture.--Agriculture in each of the geponic types has a definitely commercial outlook. The principal crops are grown for sale in domestic or foreign markets and local food deficits are made up by shipments from other parts of Spain or by import. Oranges, onions, and wine go in large quantities to foreign countries, the Vega rice crop furnishes a fair proportion of its volume for export besides supplying most of the Spanish demand for that cereal, and the more readily perishable horticultural products are sold in local markets. The wheat crop falls below the requirements of the local population and Valencia purchases wheat from the Meseta. Olive production varies from a small surplus to a deficit. The peanut crop is grown to supplement the domestic supply of olive oil, and until the national government prohibited the import of peanuts, Valencia received large quantities of oil seeds from India and China and produced a considerable surplus of vegetable oils.

Trade of major port.--The flow of commodities through the port of Valencia emphasizes the commercial nature of agriculture in the tributary area. The annual volume of trade is sufficient to attract some 2,000 vessels engaged in international trade and about the same number of coasting vessels.¹ Forty-two companies, representing 13 nationalities, furnish shipping services between Valencia and foreign ports, vessels carrying the British flag being the most numerous.² In the five-year period 1925-29, ships clearing at the port of Valencia loaded cargoes averaging 633,000 tons annually for foreign countries and 115,000 tons for Spanish ports.³ The greater part of this cargo, probably more than 90 per cent, consisted of agricultural products originating in the Vega and areas farther inland. During this period the Ferrocarril del Norte de España delivered at its port terminal an annual average of 258,000 tons of agricultural products.⁴ This is the principal railway system serving the Vega, its lines reaching Sagunto and Castellón

¹Reference 46, 1929, pp. 20-147.

²Unpublished report from Trade Commissioner Evett D. Hester to the U. S. Bureau of Foreign and Domestic Commerce, dated Sept. 16, 1929, at Barcelona; Reference 46, 1928, 1929..

³Reference 46, 1929, pp. 76-77, 130-31.

⁴Ibid., 1925, pp. 304-7; ibid., 1926, pp. 310-13; ibid., 1927, pp. 370-73; ibid., 1928, pp. 86-89; ibid., 1929, pp. 156-59.

on the north, tapping the upland agricultural area in the western part of the province of Valencia, and furnishing transportation services for the Ribera del Júcar and the Huerta de Játiva by means of the main line to Madrid (Fig. 3). The sectors marked off by these lines are penetrated by a half-dozen radially-arranged short railways which are primarily freight carriers, but for which no detailed traffic statistics are published. Connecting all the larger Vega communities with the city of Valencia is a radial system of surfaced highways which carry a heavy traffic of motor trucks and horse-drawn vehicles loaded with agricultural products. It has been estimated that the loaded vehicles which move over these highways, converging upon the two-mile avenue from the city to the port, average 6,000 daily.¹ Exports are double the imports in value and exceed them in volume by 20 per cent; but in the coastwise trade, receipts exceed shipments.² In the five-year period 1925-29 about a fourth of all ships entering the port from foreign countries arrived in ballast, but no ship sailed for a foreign port without cargo.³

The principal commodities exported through the port of Valencia are products of the soil, either in the natural state or in manufactured form, and the import trade to a notable degree serves the needs of agriculture. In the five-year period 1925-29, foods and beverages (Items 1-7 and 9a of Fig. 10) accounted for 87 per cent of the value of all exports, while non-edible products manufactured from animal or vegetable materials (Items 8, 9b, 9c, and 9d of Fig. 10) made up an additional 4 per cent. Oranges account for nearly the whole value of fresh-fruit exports, the value of onions makes up three-fourths of the total for fresh vegetables and garden fruits, almonds rank first in the list of dried fruits and nuts, and rice is the only cereal exported in important quantities. Imports show much greater diversity, but nearly a fifth of the value of all imports is accounted for by fertilizer materials, insecticides, agricultural machinery, and containers for wine and other liquids (Fig. 11). A second group of imports (Items 5-9 of Fig. 11), with a value equal to a fourth of the total, goes to supply both rural and urban industries. The manufacture of shipping

¹Reference 15, II, 72.

²Reference 46, Vols. 1925 to 1929, incl.

³Ibid., 1929, pp. 40-41, 76-77.

crates for oranges and other horticultural products consumes large quantities of sawed lumber, part of which is imported; and bags of

Groups of Export Commodities	Value in Pesetas
1. Fresh fruits.....	72,803,000
2. Wines.....	70,790,000
3. Fresh vegetables and garden fruits.....	37,482,000
4. Cereals and flour.....	27,540,000
5. Dried fruits and nuts.....	8,120,000
6. Vegetable oils and oil seeds.....	1,367,000
7. Miscellaneous foods and beverages.....	6,808,000
8. Hides and skins and miscellaneous animal products.....	3,728,000
9. Manufactures from products of the soil..	22,599,000
a. Canned and preserved fruits and vegetables.....	14,523,000
b. Tartar products.....	1,328,000
c. Essences and essential oils	2,328,000
d. Naval stores.....	3,297,000
10. All other commodities.....	<u>24,143,000</u>
Total exports.....	275,380,000

Fig. 10.--Average annual value of principal commodity groups exported from the port of Valencia in the period 1925-29 (Computed from data in Reference 46, 1925 to 1929).

Groups of Import Commodities	Value in Pesetas
1. Fertilizer materials.....	26,402,000
2. Insecticides.....	3,228,000
3. Casks and staves (for wine, olive oil, etc.).....	1,092,000
4. Agricultural machinery.....	588,000
5. Sawed lumber.....	16,195,000
6. Jute and similar fibers.....	9,760,000
7. Petroleum products.....	8,306,000
8. Coal, coke, and charcoal.....	4,598,000
9. Internal combustion engines.....	3,951,000
10. Wheat.....	9,658,000
11. Corn.....	8,104,000
12. Codfish.....	6,637,000
13. Coffee.....	2,511,000
14. Miscellaneous foods and beverages.....	6,264,000
15. Oil seeds.....	20,538,000
16. Miscellaneous textile products.....	5,669,000
17. Electrical apparatus and machines.....	2,403,000
18. Posts, railway ties, and mine timbers...	2,372,000
19. Hides and skins.....	2,316,000
20. Motor vehicles.....	2,248,000
21. All other commodities.....	<u>25,000,000</u>
Total imports.....	167,840,000

Fig. 11.--Average annual value of principal groups of commodities imported through the port of Valencia in the period 1925-29 (Computed from data in Reference 46, Vols. 1925 to 1929, incl.).

jute or other cheap fiber are required for shipping rice and potatoes. Agriculture as well as manufacturing utilizes mechanical power. Some 200 tractors are in use in the province of Valencia,¹ and the volume of agricultural products hauled by motor truck probably exceeds that shipped by rail.² The pumping of irrigation water makes use of several thousand internal combustion engines and four or five hundred steam engines, the fuel supply including both oil and coal.³

The allotment of choice waterfront space to the fruit and vegetable trade is in harmony with the prominence of horticultural products in the export trade of Valencia. The loading of horticultural exports takes place in the southwestern section of the nearly circular inner harbor, a section well located with reference to land transportation (Fig. 12). Quays and transit sheds devoted to this branch of trade line the waterfront for a quarter of a mile, and beyond the commercial esplanade flanking this section are the freight terminal of the Ferrocarril del Norte de España and that of a local railway which runs along the western margin of the Ribera del Júcar. Near the northern extremity of the fruit and vegetable section is the main entrance through which the highway traffic of the Vega enters the port.

The loading of onions, which dominated the activities of the inner harbor in August of 1931, illustrates the handling of the fruit and vegetable trade. The movement of the new crop was well under way, and ships either loading onions or awaiting a chance to load were anchored stern-to, a few hundred feet from the shore. Their number varied from three or four on the eve of a holiday to a maximum of ten or a dozen. Movements of crated onions from shore to ship originate at many points along the quay, the transit shed space being apportioned among several dozen shipping agents, who own fleets of lighters, and who take charge of moving export goods from shed to ship's hold. Crates measuring about 45 by 18 by 15 inches are moved by hand trucking from the transit sheds out on the quay and are loaded on the lighters with the aid of cranes. The

¹Reference 29, p. 23.

²Unpublished report by Consul S. Reid Thompson, dated July 22, 1932, and examined through courtesy of U. S. Bur. For. and Dom. Com.

³Reference 29, p. 23; Courtesy of D. Vicente Llinares, orange exporter and grower.

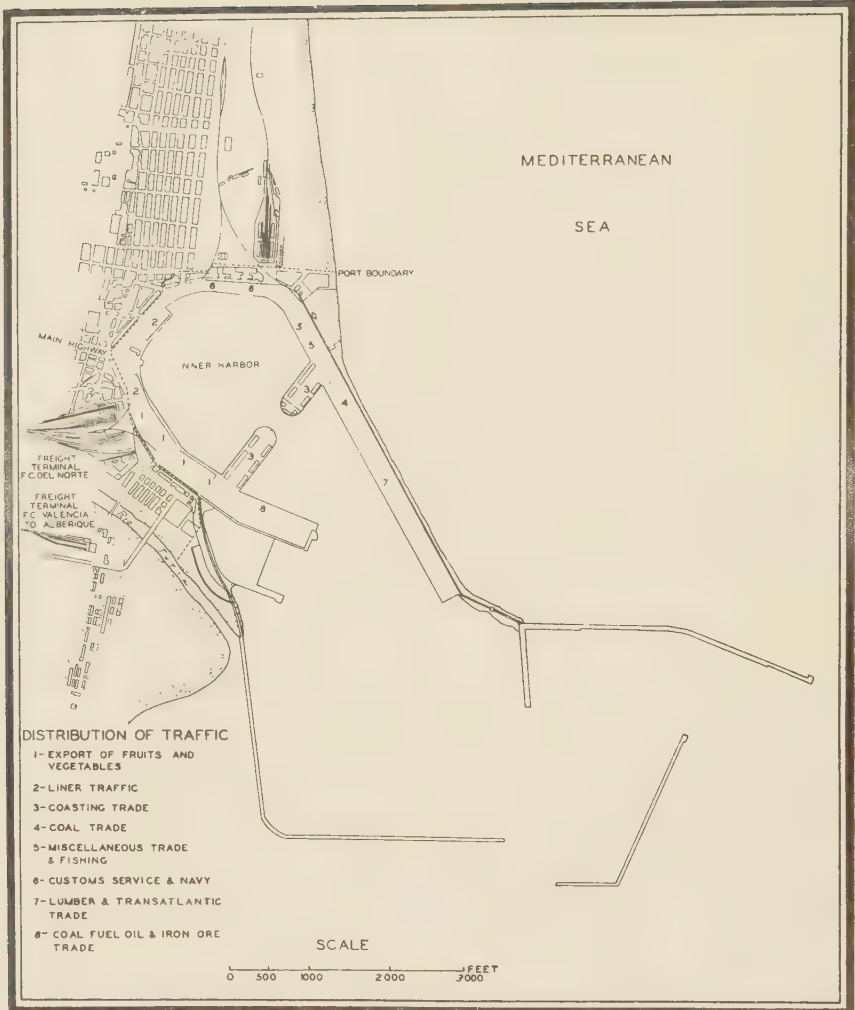


Fig. 12.--El Grao de Valencia. (Based on the following sources: "Puerto de Valencia, plano general, ano 1928," map included in Reference 46, 1928; "Anteproyecto general del Puerto de Valencia ... por el Ingeniero-Director D.Jose Fuster," Reference 11B, I, op. p. 868; Two unpublished reports by Consul S. Reid Thompson, "The Port of Valencia," dated July 22, 1932, and "Physical Characteristics of the Port of Valencia," dated Dec. 28, 1932. The reports include port map and detailed descriptions of the port, its equipment, and its administration.)

The following description draws largely upon the reports mentioned above, which were consulted through the courtesy of the Transportation Division Bur. For. and Dom. Com.

Shipping at the port of Valencia is accommodated in an

artificial harbor. The inner harbor has a water surface of 70 acres, dredged to a depth of 30 feet, and this depth is maintained by continual dredging. The outer harbor contains 395 acres, and somewhat greater depths are maintained there and in the channel leading into the inner harbor. Warehouses are provided for general cargo on the "transversals" (quays marked "3" on map), and transit sheds with brick walls at the ends and with open sides serve the fruit and vegetable trade (1). Dry-dock services are available at the Custom House Quay (6). The Muelle del Grao (2) is used by vessels carrying passengers, mail, and general cargo to and from Barcelona and the Balearic Islands. At four of the quays (2, 3, 3, 5) vessels tie up alongside. Elsewhere in the inner harbor they are moored stern-to and loaded from lighters.

Labor at the port is said to be expert and conscientious, handling goods rapidly and carefully. Thus the usual turn-around for vessels is short and the cost of handling cargo frequently is less than at other ports, in spite of a wage level considered rather high. Longshoremen number about 3,000, and some 35 master stevedores organize crews for loading or unloading. The port is supplied with twelve electric cranes, one floating crane, and some 45 small hand cranes used principally by the fruit and vegetable trade.

The port is owned by the national government and controlled by a bureau of the Ministry of Public Works, local administration being vested in a board, the Junta de Obras del Puerto, with headquarters near the custom house. The port has its own railway lines, which reach all quays of the inner harbor and connect with the railways connecting the port with its tributary area. Being equipped with a third rail, the port railway can accommodate both broad and narrow gauge cars. Eleven small tugs, and three others of 150 to 450 horse power, are available for towing. Their principal use is the movement of lighters, for most vessels enter and leave under their own power. Pilotage is compulsory both in entering and in leaving the port and for every change of position.

supply awaiting shipment is replenished at frequent intervals as two-wheeled carts and motor trucks deliver their loads across the commercial esplanade at the rear of the transit sheds.

The trade of the port of Valencia belongs mainly to the intra-regional trade of Western Europe. Of the ships entering the port from foreign countries in the period 1925-29, slightly more than three-fourths came from six European countries (Fig. 13). Ships destined for these six countries made up four-fifths of all vessels clearing for foreign ports and loaded 90 per cent of all cargo exported through the port of Valencia. The sources of imports are somewhat more widespread than the destinations of exports. In the five-year period 1925-29, each of seven countries supplied more than 5 per cent by value of the total imports, while only four countries made purchases equal to 5 per cent of all exports (Fig. 14).

1906-09 Britain took 55 per cent of Spain's export oranges, while 44 per cent went to France, Germany, the Netherlands, and Belgium; but in the period 1928-31 the four Continental countries took 54.6 per cent, while exports to Britain amounted to 38 per cent.¹ Traditionally, exports to these Continental countries, except France, go by sea to agents in port cities; but in recent years exporters in Vega cities have been making direct contacts with merchants in inland distributing centers and filling orders from these customers by rail shipments.² Cars loaded for eastern France, southern and central Germany, Austria, and Switzerland move through Port Bou-Cerbere. Those destined for Paris and the International Triangle cross the Pyrennees at Irun-Hendaye or Canfranc.³

Improved transportation facilities constitute a second reason for increased rail shipments of export products, and even some shipments for London now leave the Vega by rail. In 1932 combined rail-water freight service via Bilbao was offered through the cooperation of Spanish railways and a Cardiff steamship company.⁴ Fast freight trains make the run from Valencia to Bilbao in 50 hours, and the sea haul thence to British shores takes about three days. The new service promised that produce loaded in the Vega in the late afternoon would be delivered in London on the morning of the sixth day thereafter. Communication with British markets is speeded up even more by the establishment of car-ferry services across the Channel, permitting the transfer of loaded freight cars from French to British railways.⁵ An obstacle to the success of all-rail shipments to Britain exists in the fact that Spanish and French railways differ in gauge, this difference making it necessary to reload at the border. In the summer of 1932, experimental shipments from stations in the Huerta de Valencia and the Huerta de Sagunto tested the feasibility of shipping fresh fruits and vegetables in unit containers adapted to use on either French or Spanish flatcars. The horticultural products shipped in the containers reached London in satisfactory condition, and it was expected that a thousand containers would be placed in service the following year.⁶ A further improvement in

¹Ibid.

²Reference 49, April 17, 1933, p. 7.

³Ibid., March 15, 1933, p. 7.

⁴Reference 49, July 1, 1932, pp. 7-8.

⁵Ibid., July 1, 1932, pp. 5-6.

⁶Ibid., p. 6.

facilities for transportation to the French border was completed in 1933. This is a 75-mile cut-off which gives more direct railway communication between Valencia and Zaragoza. The saving in distance and the initiation of direct services by fast trains make a welcome reduction in the shipping time from Valencia to the western passes across the Pyrennees and consequently to the prized markets of Paris and London.¹

Balance of assets and liabilities for trade.--In commerce, as in agriculture, favoring circumstances are associated with natural handicaps. Proximity to the European Manufacturing Belt constitutes a great commercial asset, but land transportation must cross mountain barriers and the prized British market cannot be reached by all-land routes. Coastal position favors trade by sea, but a circuitous water route detracts from the advantage, the path of ships to the principal markets being more than double the air-line distances. Crop combinations in the Vega have been modified repeatedly in response to the needs of the great consuming markets, as improvements in transportation facilities have reduced the shipping time. However, these improvements have been accompanied by increasing competition on the part of distant producers, who also benefit from speedier transportation. In the principal markets of the European Manufacturing Belt, certain Vega products enjoy the prestige of long-established trade connections, but the connections are threatened at present by commercial preference based on political affiliations. The uncertainties inherent in the present situation indicate a possible need for readjustment of commercial outlook and agricultural procedure to changing world conditions. The natural endowment and cultural heritage of the area offer a wide range of choice in the utilization of resources, while the instability of commercial opportunities presents a challenge to human ingenuity.

Physical Elements of Geographic Structure

Material resources and physical conditions constitute the raw materials out of which the inhabitants of the Vega de Valencia have built the cultural structure of the area. The materials are workable - otherwise an excellent cultural structure would be impossible. They are imperfect, and their imperfections offer a

¹Reference 33, March, 1933, pp. 40-43.

challenge to human ingenuity. They are limited in quantity and variety, and thus there is need for commercial intercourse with other regions. Outstanding among the foundation features and conditioning circumstances of the geographic development are the following: (1) a sedimentary lowland fronting on the western Mediterranean; (2) a climate characterized by hot and sunny summers, nearly frost-free winters, and a scant and irregular rainfall; and (3) water resources which are available for supplementing the inadequate rainfall, but which are not particularly large, dependable, or easy of access. A balance of economic opportunity and natural handicaps has challenged the ingenuity of the inhabitants throughout the centuries; and they, accepting the challenge, have made the area more useful for occupation than they found it. They have supplemented natural processes to hasten the drainage of the lowland; they have introduced plants useful to man and suited to the natural conditions of the area; they have distributed the life-giving water of streams over the Vega and learned economy in its utilization.

Coastal position in western Mediterranean basin.--Commercial agriculture in the Vega de Valencia profits from a location on the coast of the western Mediterranean. This location facilitates transportation to the point of export, gives access to a sea frequented by abundant shipping, and offers an advantage over most competing regions in the length of sea haul required for delivering exports to the great consuming markets of the European Manufacturing Belt. Such advantages have particular significance for the area in view of the prominence of perishable commodities among its exports.

The cost of transporting commodities from farm to ship is affected favorably by the narrowness of the Vega crescent, together with coastal features which make practicable the maintenance of seven ports in a hundred-mile stretch of shore line. Every part of the Vega is within a few hours' truck haul of some point where ships load, and surfaced highways connect the principal inland centers with the ports (Fig. 3). From the greater part of the Vega, distances to a port are less than 15 miles, and large quantities of produce are hauled to the seaboard in trucks and horse-drawn carts. Of the major irrigated districts, those farthest inland are the Huerta de Játiva and the Ribera Alta (Fig. 4), the principal commercial centers of which are distant 35 and 25

miles, respectively, from the port of Valencia. Coastal position, an adequate highway system, and commercial highway carriers combine to facilitate the prompt delivery of horticultural products at a port with a minimum of damage to the perishable cargoes.

Abundance of available shipping constitutes a distinct advantage accruing from frontage on the western Mediterranean, an advantage of particular importance in view of the excess of export over import volume. The load index for inbound ships during the five-year period 1925-29 is 0.16, while that for out-going vessels is 0.27.¹ The low level of these figures indicates a generous supply of shipping which, together with an average of 169 entrances per month, should result in attractive rates and prompt loading. For oranges shipped to England by sea, rates run from ls. 1 1/2 d. to ls. 3d. for the half-size case of 50 kilograms, the charges being 9d. higher for the full-size case of 80 to 90 kilograms.² The load index for entrances probably comes nearer to representing the actual utilization of cargo space than does the figure for clearances, since the fruit ships ordinarily load at several Vega ports, while most of the import cargo is discharged at Valencia. Statements of exporters indicate that outbound ships generally carry full cargoes, at least in the orange-shipping season.³ The significance of Mediterranean frontage is suggested by the fact that 50.6 per cent of all ships entering from foreign ports and 92.5 per cent of those entering in ballast in the two-year period 1928-29 came from Mediterranean ports of France, Italy, Algeria, Tunis and Morocco (Fig. 13). Since these ships brought only a fourth of the cargo unloaded at the port, it is a fortunate circumstance that other business brought them into the region. Nearly a fourth of all entering ships came from France, and 49 per cent of all ships entering in ballast came from Italy.

Location on the western shore of the Mediterranean means relative nearness to the European Manufacturing Belt, a valuable asset for the fresh fruit and vegetable trade. In a general way this advantage is shared by all countries fronting on the Mediterranean, but produce shipped by sea from Valencia to the European

¹Computed from data in Reference 46, Vols. 1925 to 1929.

²Courtesy of D. Emilio Martínez Romero, Valencia representative of a Netherlands fruit-importing agency.

³Ibid.

Manufacturing Belt travels a shorter distance than that from the principal competing areas. For shipping to points beyond Gibraltar, Valencia has an advantage of 650 miles over the principal Italian orange district, and an advantage of about 1,800 miles over Palestine, whose orange exports have increased rapidly in recent years. Valencia onions shipped to England travel some 1,500 miles less than the competing product from Egypt. The fruit boats usually make the voyage from Vega ports to those of Britain in six to eight days.¹ This time is too long to encourage the export of such readily perishable fruits as strawberries, but it does permit the shipment of oranges, melons, and tomatoes without refrigeration. Improvements in land transportation are inviting further attention to the possibilities of trade in the more readily perishable products. Through the cooperation of French and British railways and the maintenance of car-ferry services across the Strait of Dover, the running time for special fruit trains to London during the summer has been cut to about 31 hours from Hendaye and 38 hours from Cerbere.²

Lowland surface and sedimentary materials.--Surface characteristics have an important bearing on the success of specialized agriculture in the Vega de Valencia. Severe frosts rarely occur there, while on the neighboring uplands the frost hazard at elevations of a few hundred feet precludes orange culture. The alluvial lands near the coast lie only a little above the level of the streams, a condition facilitating the distribution of water to the fields. Furthermore, the regularity of the surface has facilitated the construction of roads, without which commercial agriculture cannot thrive.

The principal surface characteristics have their origin in constructional processes. After the marine Cretaceous beds of the adjoining upland had been lifted to Meseta levels, the Mediterranean waters extended to the foot of the escarpment, occupying a deep embayment within which the present lowland was built by sedimentation. Present shore conditions and fossil evidence suggest that the constructional work has been accomplished by throwing a bar across the entrance to the bay and gradually filling the lagoon thus en-

¹Ibid.

²Reference 49, June 30, 1934, p. 5.

closed.¹ Mankind has taken part in building up the slowly emerging terrain and the work still remains uncompleted. The Albufera is an unfilled remnant of the old lagoon, whose size has been reduced greatly within historic times through the combined action of natural processes and the work of mankind. Narrow lagoons or marshes, shut off from the sea by bars, border the shore of the Vega throughout much of its length, and the agricultural history of the Huerta de Valencia includes the reclamation of extensive marshes both north and south of the Rio Turia.² The physiographic processes which have given the Vega its level surface have given it also a coast without natural harbors. The Campo de Liria and the Llano de Quart probably belong to a period of sedimentation prior to that which gave rise to the deltaic tracts. They lie at somewhat higher levels and stream valleys are cut below the general surface. The dissection is not great, but it is enough to make irrigation less simple than in the areas of newer alluvium.

A belt of low rounded limestone hills separates the Campo de Liria and the Llano de Quart from the alluvial areas along the coast. Strips of alluvium in the shallow valleys produce crops under irrigation, but the distinctive contributions of the hilly belt to the life of the area are non-agricultural in nature. Quarries in the hills have provided much of the stone used for construction purposes in Valencia.³ The deposits of fine clay existing in several localities have been utilized for ceramic purposes from remote times.⁴ The leading pottery center of the hilly belt now contains more than 90 plants, and at least 20 operate in other communities. Their products range from ordinary roofing tile to fine tableware and ornamental luster ware.⁵ The blue-tiled domes of Valencia churches and the extensive use of fine glazed tile for interior finishing testify to the importance of the hilly belt as a source of construction material. The hilly belt also furnishes slightly elevated building sites which long have been prized for summer homes by people living in the Huerta de Valencia.⁶ The at-

¹Reference 11B, I, 282.

²Ibid., p. 329.

³Reference 12, I, 146, 149.

⁴Reference 33, Nov., 1930, p. 163; Reference 12, I, 146, 158, 159.

⁵Reference 19, 1932.

⁶Reference 12, I, 147; Reference 11B, I, 183.

tractions of these sites for the families of Valencia business men have been enhanced since electric lines and motor cars place them within commuting distance of the city.

Fine-textured calcareous soils.--The soils of the Vega de Valencia are characterized in general by fine texture and high lime content. Proportions of sand and clay vary from place to place, but extreme variations are unusual. The prevailing types have good water-holding qualities. In nearly all localities the content of calcareous material is high, a soil quality favoring plant nutrition¹ and believed to affect favorably the flavor of the fruit grown.² It also favors the biological processes in the soil which fix atmospheric nitrogen,³ and the calcareous soils assimilate organic material with a promptness which the farmers graphically describe as "gobbling up fertilizer."⁴ Texture and lime content reflect the nature of the parent material and the light rainfall. Most of the soils have developed on transported materials laid down by streams. Rock outcrops in the gorge-like valleys cut in the neighboring upland reveal an abundance of limestone and marl and a relative scarcity of sandstone in the area from which the sediments were derived. The torrential character of the streams insures the transportation of much clastic material. The parent material thus consists mainly of fragmental limestone mixed with fine earthy material from the marls. Having developed in a climate too dry to cause leaching, the soils retain a large part of the calcareous content of the parent material. In the principal areas long watered artificially, the lime content has been kept up by agricultural practices.

The soils of the alluvial areas, prevailingly clay or clay loam, show adaptability to a variety of uses. They are satisfactory market-garden soils and have withstood long periods of the customary year-round cropping; in the Ribera del Júcar they furnish

¹Reference 37, Año XXIV, Num. 21 (Nov., 1930), pp. 5-8.

²H. J. Webber: "Fertilization of the soil as affecting the orange in health and disease." U. S. Dept. of Agr. Yearbook, 1894, pp. 193-202; Thomas McMullen: Handbook for Wines (New York, 1852), p. 199; Reference 5, p. 8.

³P. L. Gainey: "Influence of the absolute reaction of a soil upon its Azotobacter flora and nitrogen fixing ability," Jour. Agr. Research, XXIV (June 16, 1923), pp. 907-38.

⁴Reference 28, p. 15.

the sub-surface conditions essential for rice culture; and in the Campo de Liria and the Llano de Cuart they give good yields of unirrigated crops. In most places they lie upon thick deposits of unconsolidated sediments, but in La Plana they lie upon bed-rock which in many localities comes within one to four meters (3.3 to 13 feet) of the surface.¹ Much of the sandy shore strip remains untilled, though in some places cultivation has been pushed almost to the water's edge. The dune-covered bar between the Albufera and the sea supports a fine growth of pine. Along the western margin of the Ribera Baja runs a sandy strip which constitutes the principal peanut-growing area of the province,² and which probably marks an old beach line. In the rice-growing area near the Albufera, a high content of organic material, dark color, and mucky characteristics testify to development under conditions of imperfect drainage.³ In the reclaimed coastal marshes of La Plana the soil is a dingy red mold, spongy and of light weight.⁴

Of growing importance are the soils developed on sedimentary deposits at the foot of the mountains bordering the Vega. They have a reddish hue which varies in intensity from place to place, and as a rule they are more porous than the soils of the deltaic areas. The proportion of siliceous and argillaceous material varies within short distances, since the parent material was derived from restricted areas. In most localities the clay content runs high enough to make the soils compact rather than mellow.⁵ Typical soils of this group cover the orange-growing piedmont slopes on the eastern margin of the Ribera Alta, the parent material having been derived largely from a reddish sandy clay marl which is interbedded with the limestone of the Corbera-Gandia mountain group (Fig. 4). Orange trees grown on the piedmont soils require more fertilizer and more irrigation water than those grown on the clay soils of the deltaic tracts, but the vigor and large size of the trees testify to excellent growing conditions. To the

¹Reference 11D, pp. 99-100.

²Rafael Janini and Manuel de Torres: "Algo respecto al cacahuete," Reference 2, May, 1931, pp. 3-7.

³Reference 12, I, 170, 189.

⁴Carles Salvador: "Marjales y alquerías," Reference 33, October, 1932, pp. 156-57.

⁵Courtesy of Vicente Llinares.

same group belong the soils devoted to the production of table grapes on the gentle south-facing piedmont slopes at the extreme northern limit of La Plana. The piedmont deposits of this locality have been derived from mountains consisting of sandstone with some layers of limestone, and the reddish soils are dotted with sparkling flecks of mica. Little water is available for irrigation, but the soil texture favors the production of the vine and deep-rooted tree crops without irrigation.¹ Other soils of this group cover the sedimentary deposits at the foot of the range which extends west from Sagunto and forms the northern wall of the Campo de Liria. A firmly cemented sandstone which constitutes the dominant rock formation of the range has contributed largely to the parent material. The soils, coarser and more siliceous than most Vega soils, are suitable for vine culture, but their water-holding qualities are too poor for the production of cereals without irrigation.² These soils, unlike those in many sections of the Vega, prove congenial to American varieties of wild grape, and the restoration of vineyards after the phylloxera invasion was accomplished with relatively little difficulty. They also are suitable for citrus culture, and near Sagunto many of the vineyards have been supplanted by orange groves.³

The group of soils known in Spain as albarizo have a restricted distribution in the Vega as a whole but cover considerable areas in the valley of the Rio Albaida (Fig. 4). There the principal mineral constituents of the soil were derived from a poorly cemented white clay marl which is the most widely distributed country rock of the area. The soils contain much calcareous material which shows little or no chemical alteration, and their whitish or yellowish color gives the landscape a dazzling appearance. When dry they may be hard and compact, and after irrigation or a heavy rain a calcareous crust sometimes forms on the surface with fatal effects to delicate vegetation. However, they assimilate organic fertilizer very rapidly and under favorable moisture conditions can be kept mellow by cultivation.⁴ Their mineral content and physical characteristics make them unfit for orange cul-

¹Reference 48, p. 706.

²Reference 11A, p. 791.

³Reference 43, p. 18.

⁴Reference 12, I, viii; Reference 48, p. 688; Reference 11A, pp. 793-94.

ture,¹ but they are excellent vineyard soils and have water-holding qualities suitable for cereal production under dry-farming methods.² Because of the predominance of calcareous materials in the g-barizo soils the restoration of vineyards through the use of American stock proved very difficult in the Albaida Valley, and in some localities the vineyard lands were diverted to cereal culture.³ Almond trees thrive in these soils, particularly near gypsum beds, outcrops of which are common in the hills and neighboring mountains.⁴

Hot summers and mild winters.--Hot and sunny weather in summer, together with winters nearly free from frost, constitutes a valuable asset for commercial agriculture in the Vega de Valencia, particularly when associated with proximity to the European Manufacturing Belt. All months are warm enough for plant growth, the average minimum temperature for the coldest month being above 40° F.; while July, August, and September, the months in which the grape and rice crops mature, regularly have maximum temperatures averaging above 80° F.⁵ Light frosts occur but severe frosts are very rare. The southern point of the Vega is in the approximate latitude of Sacramento, California, but Valencia has milder winters than the California city. The temperature curve for Valencia very closely resembles that of San Bernardino, which is situated about 5 degrees farther south but at an elevation of 1,000 feet (Fig.15).

Light frosts occur with sufficient frequency to constitute a hazard for orange culture. The frost hazard recurs annually, but weather data for Valencia,⁶ situated midway between the two major orange-growing districts, suggest that chances for escaping frost are a little better than in the San Bernardino district of California (Fig. 16). In eight years of the period 1913-31, the minimum temperature at Valencia was above 32° F., whereas in Redlands (California) frost was recorded every year. In Valencia the minimum for the year ordinarily is between 27° F. and 35° F., and

¹Courtesy of Don Vicente Llinares.

²Reference 12, I, viii; Reference 11B, II, 25, 31, 33, 47.

³Reference 11B, II, 25.

⁴Ibid., pp. 2, 50, 59, 73; Reference 12, I, viii.

⁵Based on data furnished by the University of Valencia.

⁶Temperature records are published only for the provincial capitals.

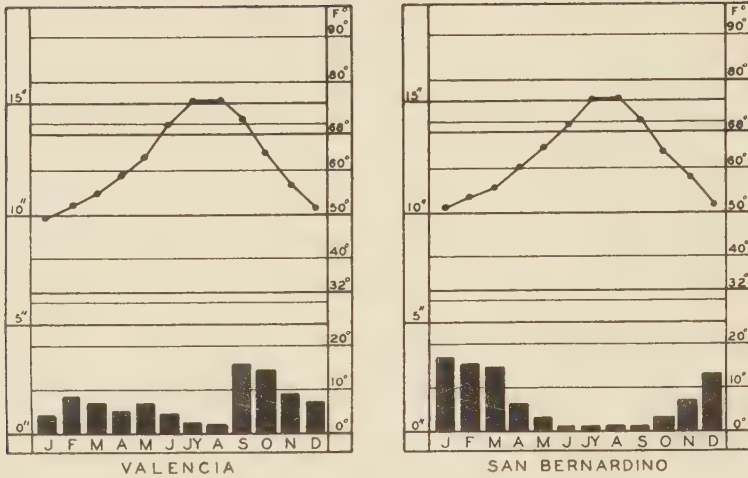


Fig. 15.--Normal monthly temperature and precipitation for Valencia and for San Bernardino, California. (Data for Valencia from Reference 41; those for San Bernardino from U. S. Weather Bureau Bulletin W. Averages are for 30 and 38 years, respectively.)

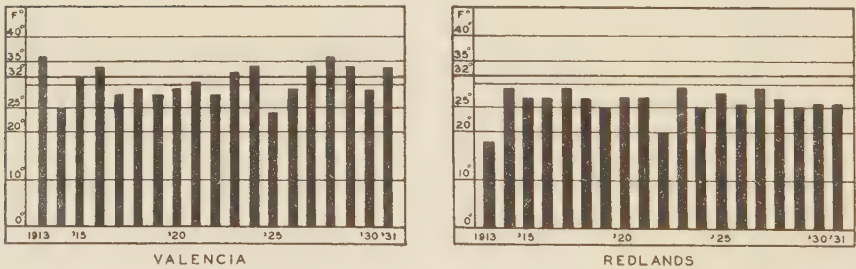


Fig. 16.--Annual minimum temperatures for Valencia and for Redlands, California, 1913-31 (Data for Valencia from Reference 41; those for Redlands from U. S. Weather Bureau, Climatological Data, summary number for each year).

in only three years from 1866 to 1930 did the temperature fall below 25° F.¹ With this narrow range of minimum temperatures, there is danger of frost every winter, and frost injury to crops varies from place to place according to elevation, slope, and exposure. Local agronomists estimate that frosts severe enough to injure 60 per cent of the orange crop occur about once in ten years.² The danger of frost is greatest from the middle of December to the end of January, but temperatures of 32° F. or lower have been recorded as early as November 21st and as late as March 11th. Rarely do frosts occur in more than one month of the winter, but in occasional winters temperatures of 32° F. or lower are recorded in two or three months; and in the winter of 1890-91, frost occurred in every month from November to February inclusive, and on March 24th the temperature dropped to 33° F.³ The minimum for the sixty-year period (18° F.) occurred in January of that season.

Scant and irregular rainfall.--High yields from Vega land are secured in spite of adverse rainfall conditions. The mean annual precipitation, based on records for sixty-four years, is 17.7 inches.⁴ Inadequacy of precipitation is aggravated by high summer temperatures, the average for July and August being slightly above 75° F., or about the same as that of the hottest month in the American Corn Belt (Fig.15). The seasonal distribution of precipitation shows Mediterranean characteristics in that the minimum occurs in the hottest part of the year. About 70 per cent of the annual precipitation occurs in the six-month period from September to February, while July and August, the hottest months, receive less than 5 per cent. Moisture conditions would be unfavorable for most crops even if the rainfall of individual years conformed to the normal distribution, but difficulties are aggravated by extreme irregularity, both from season to season and from year to year (Figs. 17 and 18).

¹Reference 41, 1866 to 1927, incl.; Reference 42, 1928 to 1931, incl.

²Courtesy of Manuel Herrero de Egaña, agronomist on the staff of the agricultural experiment station at Burjasot, near Valencia.

³Reference 41.

⁴Rainfall data furnished in recent years by many cooperating stations scattered throughout the provinces of Valencia, Castellón, and Alicante give the impression that most parts of the Vega receive more rain than does the lowland belt extending from Valencia through Liria. However, the records are interrupted too frequently to offer conclusive evidence.

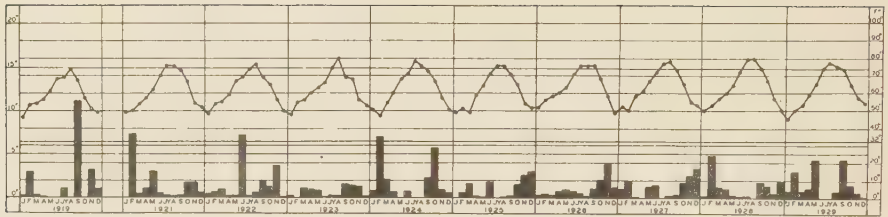


Fig. 17.--Monthly rainfall and average monthly temperature for each of ten years (Data from the University of Valencia). The characteristics of the temperature curve are in harmony with the northerly latitude, and the winter average indicates the absence of severe frosts. The rainfall record for individual years bears little resemblance to the normal curve, and the drought which nearly always occurs in July and August is almost the only feature suggesting the Mediterranean rainfall type.

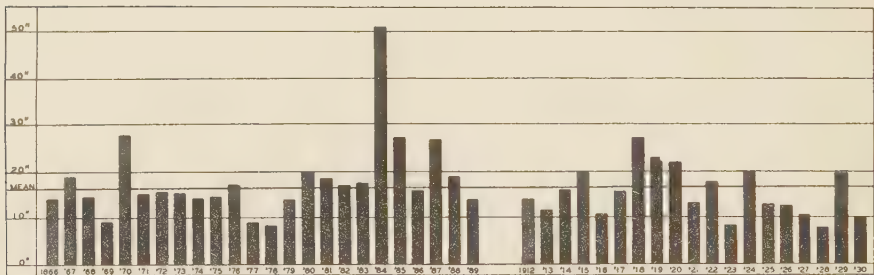


Fig. 18.--Rainfall for individual years, 1866-89, 1912-30 (Data from Reference 41, Reference 42, and records furnished by the University of Valencia). The grouping of years with excess or deficiency of rainfall is characteristic of Valencia climate, as is also the fact that years with less than normal precipitation outnumber those with more than the average amount.

The curve showing average monthly precipitation represents probability rather than usual amounts, and the annual total is subject to extreme fluctuations. Within the period 1866-1930, the precipitation of individual years varied from 8 to 51 inches. There were 38 years with less than normal precipitation, and in each of ten years the rainfall was less than 10 inches. Years with rainfall above or below the average have a tendency to occur in groups. For example, 12 out of the 14 years from 1866 to 1879, nine out of the eleven years from 1907 to 1917, and eight out of the ten years from 1921 to 1930 had less than normal precipitation; while in the fifteen-year period ending with 1898, all but four years had more than the average amount.

The seasonal distribution has some mitigating features. Instead of a true winter maximum, the curve of average rainfall distribution shows an early-autumn maximum, with a secondary maximum occurring in early spring (Fig. 15). December and January, harvest months in the orange groves, are relatively dry. This is a desirable condition, since rain interrupts the picking of fruit, and since orange growers endeavor to keep their trees in a semi-dormant state until the fruit is gathered and the danger of frost is over. On the whole, September offers the greatest probability of rain, with February ranking second. There is a decline in probability from September through January and a less regular decline from February through August. Rarely does the distribution for a single year approximate that of the long-term average. Rains totaling two inches or more may fall in any month, though they rarely occur in July or August (Fig. 17). Periods of at least two months with a total rainfall of less than a half inch occur on an average in about three years out of four. In the 64 years from 1866 to 1929 there were 69 such periods, affecting 45 years. In twenty-five years the drought¹ either had a length of three months or else was repeated. July and August normally are dry months, and frequently June is nearly rainless, but the total number of droughts occurring at other times of year is nearly equal to the number falling within the summer months (Fig. 19). These erratic rainfall conditions make cereal cultivation without irrigation too uncertain for profit.²

¹A drought for purposes of this discussion is considered arbitrarily as a period of two months or longer with a total rainfall of less than an inch.

²Reference 11A, p. 790.

Time of Occurrence	Number of Droughts
May, together with April or June.....	9
Wholly within the period June 1 to August 31.....	30
Summer droughts lasting through September.....	7
Other times of year.....	23
Total.....	69

Fig. 19.--Seasonal distribution of droughts from 1866 to 1929 (Computed from data in Reference 41).

Resources of stream water.--The rivers which cross the Vega have vital significance for the human occupancy of the area. Although much land is cultivated under dry-farming methods, life in the Vega and the fame of Valencian agriculture depend primarily upon irrigated crops. Even in the localities where commercial crops are watered only by the rainfall, tracts of irrigated land devoted to food and forage crops constitute essential functional forms of the villages. The estimated amount of Vega land irrigated from the principal streams and their tributaries is not far from 200,000 acres.¹ The total of the areas cited in the official list of concessions for the use of stream water (Fig. 20) falls only a little below this amount, and the list contains several dozen concessions for the use of water from tributary streams with no estimate of the area to be irrigated. Until recently, streams have supplied water for nearly all the irrigated land, though wells have watered small tracts. Only within the last few decades has ground-water played a major role in the irrigation of Vega land.

The streams that supply water for the Vega are relatively small, their number embracing no major river of the Iberian Peninsula (Fig. 1). The total catchment area tributary to Vega streams measures about 16,700 square miles,² or less than 8 per cent of the surface of the peninsula. At medium stage, the combined volume of the Júcar and the Turia, which drain about two-thirds of this area, averages less than a fourth that of the Guadalquivir and is equal to only 6 per cent of the volume of the Ebro.³ Furthermore, the regime of these streams is far from regular (Fig. 21).

¹Estimated from data in references 11, 29, and 40, together with unofficial estimates from various sources.

²Reference 42, 1931, pp. 5-6.

³Reference 40, pp. 114-129, 134-139.

Source of Water	Where Used	Area Irrigated	
		Hectares	Acres
Júcar System			
Main stream	Ribera Alta and Ribera Baja	35,165	86,894
Tributaries			
Sellent	Ribera Alta	574	1,418
Albaida	Huerta de Játiva	1,800	4,448
Turía System			
Main stream	Campo de Liria	3,393	8,384
Main stream	Huerta de Valencia	11,751	29,037
Mijares System			
Main stream	La Plana	11,700	28,911
Tributary			
Viuda	La Plana	400	988
Palancia System			
Main stream	Huerta de Sagunto	7,727	19,094
Serpis System			
Main stream	Huerta de Gandía	4,300	10,626
Tributary			
Vercusa	Huerta de Gandía	900	2,224
Total		77,710	192,024

Fig. 20.--Concessions for use of water from principal river systems to irrigate land in the Vega de Valencia (Reference 40, pp. 433-45).

Average conditions for an eight-year period show the maximum flow as occurring in late winter or spring, with the minimum in summer and early autumn. Thus the season of maximum temperature and minimum rainfall is characterized also by low water in the streams. Irrigation needs draw so heavily upon the available supply that in summer no stream except the Júcar ordinarily delivers water to the sea. Moreover, stream flow is subject to wide aperiodic fluctuation (Fig. 21), entailing serious water shortages in some years and causing destructive floods in others. Protecting walls built along the Turia in Valencia and on the left margin of the Júcar in the Ribera Baja testify to the danger of inundation.

Significant for the utility of the Júcar and Turia rivers is the fact that their headwaters flow through an area with precipitation greater than that of the coastal lowland. They rise on the main stream divide of the peninsula, to which belongs the rugged mountain belt in the provinces of Cuenca and Teruel. There, within 100 miles of the Mediterranean, the higher ranges rise to elevations of more than 6,000 feet. The Júcar and the Turia rise in mountain valleys less than twelve miles apart, but the Júcar takes

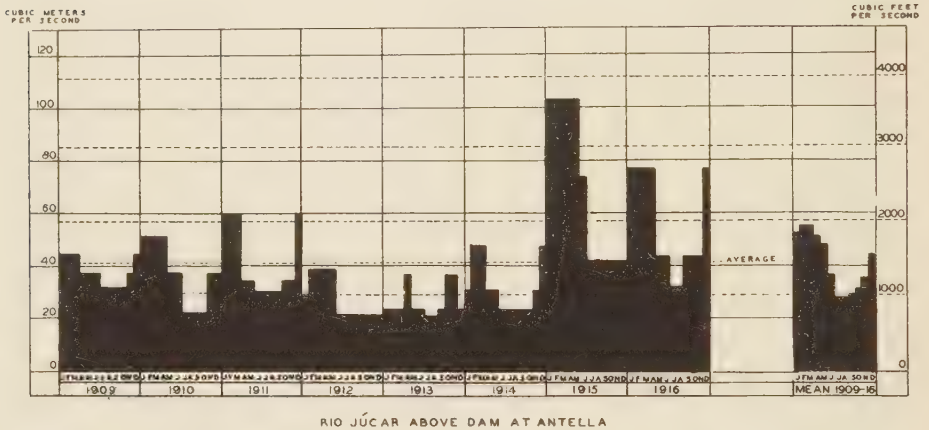
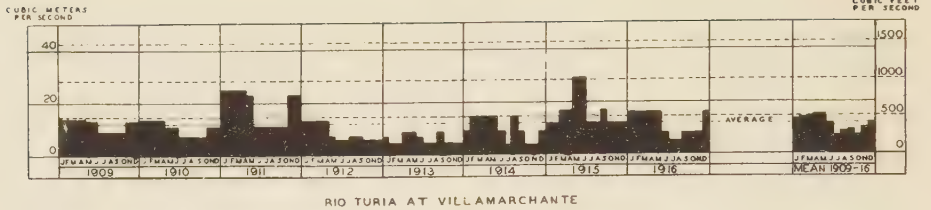


Fig. 21.--Monthly regime of the Turia and Júcar rivers, 1909-16, and average monthly flow for the period (Computed from stream measurements given in Reference 40). The stream measurements were taken near the points where the two rivers enter the Vega de Valencia. The Júcar records were taken just above the origin of the Acequia Real del Júcar. Below this point the river changes abruptly to a meandering stream. Below Villamarchante the Turia flows for ten or eleven miles in a valley incised below the general level of the Campo de Liria. The irregular regime of the rivers is in harmony with the erratic character of the rainfall; and in accordance with the wide fluctuations in flow, floods and water shortages threaten the deltaic areas dependent on these streams.

a more indirect course than the Turia and collects the drainage from a larger area (Fig. 22). Weather records for short periods indicate moderate rather than heavy precipitation for the headwaters area. The station nearest the sources of these streams shows an annual average of 48 inches for two five-year periods. The averages for other stations in the general area run from 16 to 39 inches and suggest somewhat higher precipitation for the upper Júcar basin than for that of the upper Turia. The period of record is too short for dependable generalization, but a seasonal distribution not radically different from that of the Vega is indicated, with wide fluctuations in amount and seasonal distribution.

Certain characteristics of the upper stream basins tend to diminish the effects of erratic precipitation on stream flow. Coniferous forests under government management cover the mountain slopes of the headwater area and retard the rate of run-off. This is one of the principal forest sections of Spain, the government-owned pine forests in the provinces of Cuenca and Teruel amounting to 642,000 acres.¹ Winter precipitation takes the form of snow in this section, and temperatures are low enough so that on the pine-clad ranges the snow lies for months, thus providing natural storage until late spring or early summer. Most of the tributaries, particularly in the upper and middle courses of the principal streams, originate in springs, which are plentiful in the upland west of the Vega.² The rock foundation of the upland consists mainly of jointed limestone, which permits water to sink below the surface, thus diminishing the run-off; and springs opening on mountain slope or valley wall mark the outcrop of impervious strata of shale or marl interbedded with the limestone.³ Natural conditions provide storage sufficient to give most of the tributaries in the upland section a permanent flow, but not sufficient to prevent wide fluctuations of volume in the lower courses of the main streams. The serious effects of a severe drought were evident in the summer of 1931. Less than ten inches of rain had fallen in 1930, the winter had been abnormally dry, and the spring had been practically rainless. The summer shortage of irrigation water was extreme, and the irrigation officials were driven almost frantic by the insistent

¹Reference 42, 1931, p. 126.

²Reference 11A, pp. 172-208.

³Reference 12, I, vi.

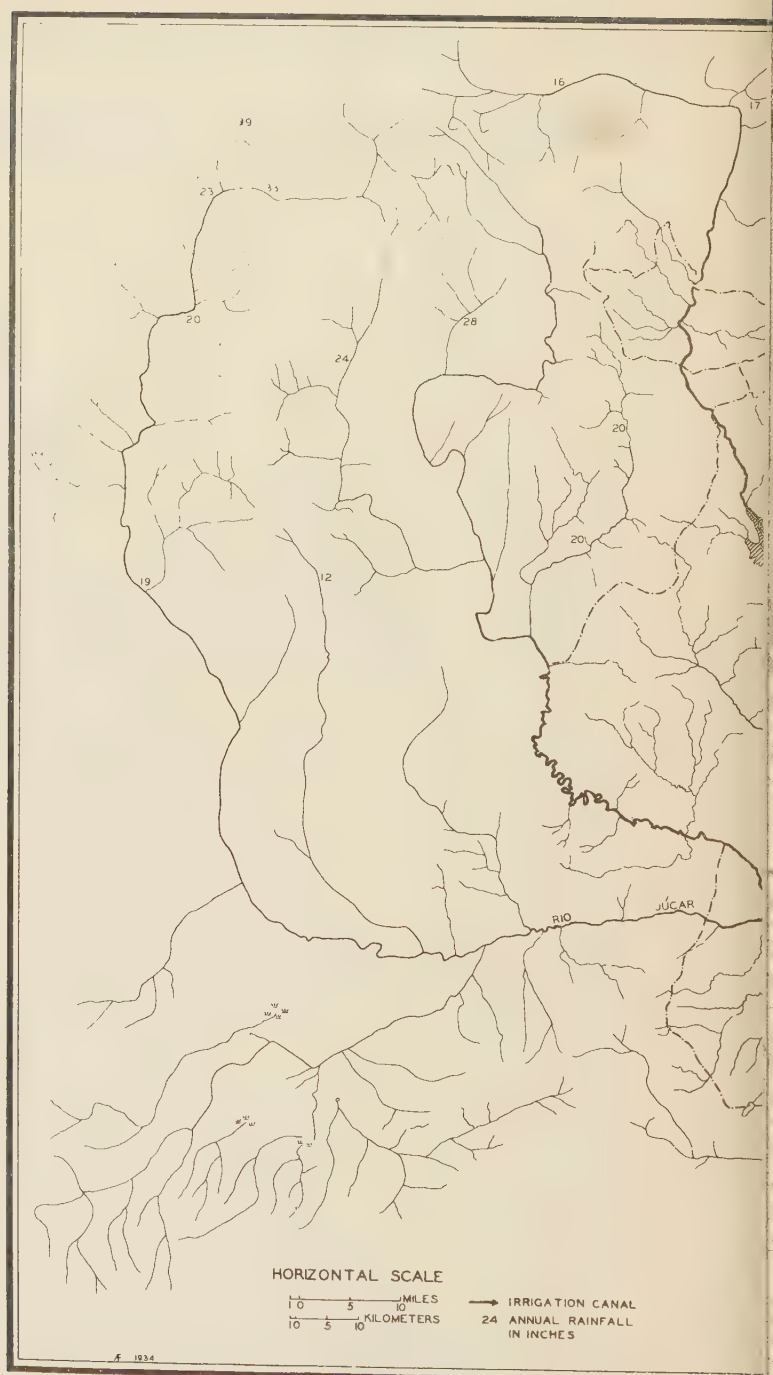
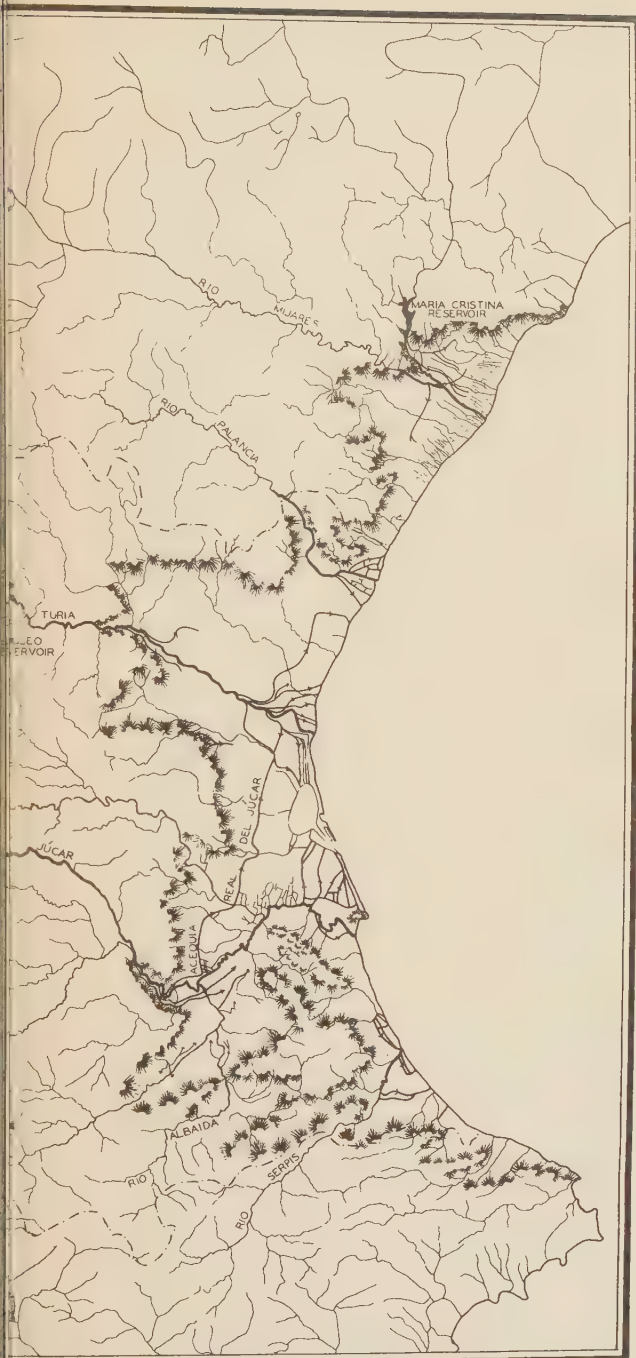


Fig. 22.--Catchment basins tributary to Vega str. ence 15, Vol. III, plates XLII, LXXII).



ased on Map references 1, 2, 4, 5, and Refer-

pleading of farmers for water to save their crops.

Irrigation practices and canal regulations have been worked out with the fact of water scarcity in mind. Domestic uses of water have precedence over the irrigation of fields, and there is an established order of precedence for crops of different kinds. Water conceded for one type of culture may not be used for a different type. Penalties are imposed on irrigators found guilty of wasting water, and a canal official may turn the water off a field if the farmer fails to do so at the proper time. Detailed instructions for procedure in times of shortage were embodied in the canal ordinances at a very early period. While the shortage continues, canal officials are given extraordinary powers. They are authorized to disregard the established order of distribution and furnish water first to localities most in need of it. Water for irrigating tree crops may be refused until the needs of all annual crops have been met. When the supply is too low to provide an adequate irrigation head with all districts receiving the usual continuous flow, they may distribute water to the various districts in turn. At such times, irrigators must prepare their fields with soil ridges so placed as to permit irrigating the plants with the minimum amount of water. In times of extreme scarcity, certain communities drawing water from the Rio Turia above the delta are required to relinquish their rights on specified days of the week for the benefit of the Huerta de Valencia.¹

The regulation of stream flow by means of storage reservoirs would diminish greatly the hazard of water shortage in the Vega de Valencia, since the streams carry more water at flood time than can be used. The seriousness of water losses during floods is illustrated by conditions in 1930, when the total rainfall, as already pointed out, was abnormally scant. Government engineers estimate that 90 million cubic meters of water went over the lowest diversion dam of the Turia system in that year to be wasted.² This is just about the quantity of water required to irrigate the Huerta

¹Based on the canal ordinances included in Reference 30 and the ordinances for the government of the Acequia Real del Júcar (Reference 1).

²Spain, Obras Públicas, Division del Júcar: Proyecto del Estanque Benagüéber en el Rio Turia, Anejo Num. 5, p. 3 (unpublished). The document was examined through the courtesy of the Division del Júcar in Valencia.

de Valencia for three months. The absence of adequate storage facilities probably is due to a combination of physical and political conditions. In view of the nature of the stream pattern, the provision of adequate storage will be a costly matter. Since five river systems and several smaller streams deliver irrigation water to districts separated by topographic barriers, no single reservoir can serve more than a small part of the whole area. The handling of the reservoir projects by cooperative action of the irrigators is not feasible, both because of the magnitude of the work and because suitable reservoir sites in nearly all cases lie outside the jurisdiction of the communities interested in storage. The inauguration of such projects by a province is out of the question, for the provinces serve primarily as administrative divisions under a highly centralized government and have little power of initiative or command of funds. In fact, the revolutionary movements that have disturbed Spain since the 1860's have been motivated in large part by the demand for a higher degree of local autonomy. It was stated in 1931 that even the expenditure of city funds in Valencia required the approval of the national government.

Since the beginning of the present century the national government has given some measure of attention to public works for the benefit of irrigation. A survey was ordered in 1902 for the purpose of discovering the characteristics of possible reservoir sites. By 1921, sites had been chosen for ten reservoirs in six drainage basins tributary to Vega streams, and work on two of the reservoirs was in progress.¹ The 1920's saw the completion of these two, the María Cristina Reservoir, which stores the flood waters of an intermittent tributary of the Río Mijares for use in La Plana, and the Buseo Reservoir, built to store the waters of a minor tributary of the Río Turia for use in the Huerta de Valencia (Fig. 22). More recently, work has begun on the Blasco Ibanez Reservoir in the western part of the province of Valencia. According to estimates, the combined cost of the three reservoirs will be about 13,000,000 pesetas.² They are expected to make possible an addition of some 42,000 acres to the irrigated land of the Vega, besides diminishing the hazard of water shortage on land already irrigated in La Plana and the Huerta de Valencia. The national

¹Reference 15, I, 266-67, 271-75, 286-89.

²Ibid., pp. 267, 289; Reference 11D, p. 391.

government supervises construction and assumes a share of the cost which generally amounts to about half, but which in the case of the Buseo Reservoir was 80 per cent. In 1933 the government of the Spanish Republic took up the work on a more comprehensive scale and has formulated a twenty-five-year program of developing water resources for irrigation. The completed plan is expected to benefit 43,000 hectares (106,425 acres) of land already irrigated in the Turia and Júcar basins and to provide water for irrigating an additional area of 95,000 hectares (234,749 acres) in these basins.¹

The nature of the terrain has an important bearing on the distribution of stream water in the Vega. Irrigation from streams is restricted in the main to the newer alluvium of deltaic areas and of valley floors. In the lower course of each stream, water is diverted by a series of dams which serve to turn the water into the canals, but which do not create reservoirs. The most westerly of the dams that divert water from the Rio Turia to irrigate land within the limits of the Vega is located some twenty-five miles from the sea, but the first of the canals that water the Huerta de Valencia taps the stream about seven miles above the city. The principal canal of the Júcar system, the Acequia Real del Júcar, has its origin some forty miles (river distance) from the mouth of the river (Fig. 22), but several smaller canals which originate five or six miles farther up-stream also deliver water to Vega land. The canals spread out over the deltas in divergent courses, somewhat resembling those of natural distributaries. Throughout most of their length they are unlined, but masonry works exist at critical places, and some of these are notable feats of engineering. As an example, the canal which taps the Rio Mijares on the left to water La Plana may be cited. The water diverted from the river is led through a projecting mountain spur by means of a tunnel a quarter of a mile long, is carried by a siphon under the channel of an intermittent stream subject to violent floods, and then flows for some 60 rods in a subterranean channel.² The siphon is used twice in the course of the Acequia Real del Júcar to avoid the hazards occasioned by the torrential nature of inter-

¹Spain, Ministerio de Industria y Comercio: Informacion Comercial Española (Madrid, monthly publication), April, 1934, pp. 87-97.

²Reference 11D, pp. 251-52.

mittent streams crossed, and the same device is repeated many times in the Vega. Works of masonry exist at the origin of both main and branch canals, where weirs give each channel its allotted share of the total flow. In general, the waters of the canals flow between banks of compact clay strengthened by the roots of fruit trees, shrubs, or reeds; and on each side a strip of specified width is left unplowed. In these strips the trampling and grazing of livestock are prohibited and the cutting of vegetation regulated to prevent weakening the margins of the canals.¹ While it is believed that from most of the canals the loss by seepage is not great, the question of lining the channels comes up from time to time. The Acequia Real del Júcar is known to lose much water, and plans to line it throughout its length have been made. However, the execution of the plans is delayed by the magnitude of the cost and the fact that the canal is in use nearly all the year.²

So far as areas of the Alboraya and Alcira types are concerned, the available sources make no mention of undesirable effects on soil characteristics or ground-water level caused by irrigation. It seems clear, however, that the danger long has been recognized and that irrigation practices guard against its occurrence. Canal regulations make an irrigator responsible for damage and subject to fine if through carelessness or failure to provide drainage channels for his fields he causes his neighbor's property to be damaged by seepage.³ The marshy condition along the shore may be aggravated by the diversion of water from streams. Numerous springs issue from the earth within two or three miles of the sea and discharge their waters into the shore marshes.⁴ Whether the springs are fed, in turn, by water from the irrigated fields is not clear. The shore belt is veined with drainage ditches, and in many cases the same ditch serves both for drainage and for irrigation.

In the Ribera del Júcar, irrigation clearly has raised the ground-water level, and this fact probably has some bearing on the persistence of rice culture. Cavanilles was told that the extent of marsh land increased after the newer section of the Acequia Real

¹Reference 1, p. 12; Reference 15, II, 160; Reference 30, I, p. 154; *ibid.*, Vol. II, Part II, pp. 93, 144, 172-73.

²Reference 15, I, 282. ³Reference 30, Vol. II, Part II.

⁴Reference 12, I, 103, 129; *ibid.*, II, 142.

del Júcar was built and that the ground-water level had risen to within a few inches of the surface in many fields formerly cultivated under dry-farming methods. As proof that irrigation works had affected the ground-water level, he cites the failure of nearly all wells in Sueca after the breaking of the Cullera dam. He believed that the marshes in the Ribera Alta would disappear if the people would abandon rice culture and repair the irrigation canals.¹

Stream water is supplied in the Vega at remarkably low cost. No charge is made for the water itself, which is considered public property even after diversion from the streams. Canal dues merely cover maintenance and administration expenses, and the general level of annual charge is not far from 5 pesetas per acre.² The low level of cost is due in part to the fact that the irrigation systems are owned and operated by organized communities of landowners; but a large share of credit must be given to the enduring character of construction by unknown builders of other centuries. Dams, aqueducts, and siphons still perform the functions for which they were constructed, though they have stood so long that no records reveal their origin. Additions to irrigation works have been made at intervals, but the main structure of the canal systems is shown by official documents to have been in operation at the end of the Moorish period. No construction costs, therefore, are included in the annual charges, and maintenance operations, except for the annual cleaning, are of slight importance. The land irrigated from the Acequia Real del Júcar in the Ribera Baja is on a somewhat different basis. Until the latter half of the 18th century the canal extended only to Alcira and Algemesi. The lower section was built by private interests under a concession granted by the Crown. The concession required that land watered from the new canal should pay annually to the builder (who is designated the proprietor of the canal) 5 per cent of the value of the crops grown, in addition to the customary dues for administration and upkeep. The latest revision of the canal ordinances guarantees to the heirs of the builder "all the rights which they have enjoyed up to the present."³

¹Ibid., I, 170-72, 190.

²Reference 1, p. 16; Reference 30, Vol. II, Part II; estimate of current rates by D. Vincente Llinares.

³Reference 12, I, 135; Reference 11A, p. 273; Reference 30, I, 440-68; Reference 1, p. 27.

The streams which cross the Vega furnish power as well as irrigation water. An official report covering the period 1909-16 lists 450 developed power sites in the basins of the Mijares, Palancia, Turia, Júcar, and Serpis rivers.¹ These are of two groups. The more numerous group is made up of sites affording small volumes of power but having convenient locations with reference to communities in need of power. Scores of such sites are developed in the Vega and in the occupied valleys of the neighboring upland, even the flow of springs and irrigation canals being utilized in some instances. These minor sites, in many cases affording less than ten horse power, are occupied mainly by small flour-milling, rice-hulling, textile, and paper-manufacturing plants. The group of power sites more important under present conditions comprises many whose potential capacity is measured in hundreds or thousands of horse power. Such sites are restricted to the main streams and their larger tributaries and to the upland sections of the basins, but a number are located near the inland margin of the Vega. Located in rugged areas with relatively few people and consequently small power requirements, these sites did not invite development until electrical engineering permitted the transmission of power to more densely peopled areas. Electrical power now is generated at more than a hundred sites, and ten of the major hydro-electric developments together have an estimated capacity of 151,300 horse power available during nine months of the year.² The hydro-electric power generated in the neighboring upland constitutes a supply on which the people of the Vega draw for transportation, manufacturing, and agricultural purposes.

Under the existing water law, water power concessions are made by the Ministerio de Fomento, but in specified cases the matter can be handled by the civil governor of the province without submitting the application to Madrid. Concessions are granted only to Spanish individuals or companies and for periods not exceeding 65 years, after which the site, together with all improvements and machinery, reverts to the national government. If the water power is to be used for public utilities the level of rates must be justified in the plans submitted.³

¹Reference 40, pp. 810-27, 950-55.

²Reference 42, 1928, pp. 174-76.

³"Salto de agua," Reference 20.

Ground-water resources.--Ground-water constitutes a resource of growing importance in the Vega de Valencia. The amount of land irrigated from wells probably exceeds 130,000 acres. The greater part of this area has been brought under irrigation in relatively recent times. It was estimated in 1921 that water to irrigate about 6,000 hectares (14,826 acres) in the province of Valencia was drawn by power pumps from wells completed in the preceding four decades, while nearly 12,000 hectares (29,653 acres) were irrigated from older wells equipped with horse-power norias instead of modern pumping machinery.¹ In 1931 the Cámara Oficial Agrícola of Valencia estimated that 35,000 hectares (86,487 acres) had been added to the irrigated area of the province since the beginning of the present century, the increase being due almost wholly to individual initiative in exploiting ground-water resources.² Local authorities estimated for the same year a total of about 5,000 wells used for irrigation in the province of Valencia, and supplying water for approximately a third of the 143,800 hectares (355,366 acres) irrigated in the province.³ A conservative estimate of the land irrigated from wells in La Plana brings the total to the 130,000 acres given above. The significance of ground-water resources for commercial agriculture is emphasized further by the fact that a large proportion of the land irrigated from wells is devoted to the cultivation of oranges, the leading export crop of the Vega. The expansion of orange culture has been accomplished largely through the exploitation of ground-water, for in general the best orange land lies on the piedmont slopes above the level of the canals.⁴

Recent interest in the development of ground-water resources has been stimulated by certain definite attractions of irrigation from privately owned wells. The dependability of the supply constitutes a major advantage. While some shallow wells may fail in extreme droughts, as happened in 1931, the supply stored underground is less subject to seasonal fluctuation than is the volume of streams, and the flow of many of the deeper wells shows no tendency to vary with the rainfall. A second advantage is the pos-

¹D. Luis García Ros: "Los pequeños riegos en la región de Valencia," Reference 15, III, 109-10.

²"El laboreo de la tierra," Reference 2, June, 1931, pp.2-3.

³Courtesy of D. Manuel Herrero de Egaña.

⁴Ibid.

sibility of adjusting the irrigation interval to the needs of individual crops. The owner of a well has access to his water supply at all times, whereas water from a canal is assigned to individual properties only during specified hours on days fixed by the canal authority.¹ Irrigation needs so severely tax the resources of stream water that land not irrigated at the appointed time must await the owner's next turn. The nature of the water rights constitutes a third attraction of irrigation from wells. Concessions of water from canals merely convey the right to irrigate specified tracts of land; while the surplus, if such exists, remains state property.² Ownership of a well, in contrast, gives the proprietor the right to sell water if he chooses. Many owners do sell the surplus water from their wells. In 1931 their prices varied from 5 to 10 pesetas per hour, an hour's flow aggregating 60 to 80 cubic meters.³ By 1933 the effects of the depression and the increased number of wells had brought prices down to a new level of 3 to 4 pesetas.⁴ Water from wells usually is pumped to storage reservoirs, whence it is distributed to the fields through underground pipes.⁵ There it flows in concrete channels until released for actual use.

The wells of the Vega tap aquifers lying at different depths. In the Huerta de Valencia, wells penetrate successive layers of sedimentary materials which are known to have a total thickness of 80 to 100 meters (262-328 feet), and which include five or more water-bearing layers of sand or gravel separated by beds of clay (Fig. 23). For a long time, wells 10 to 15 meters (33 to 49 ft.) deep have furnished water from the first aquifer, but many of the newer wells draw upon the more generous supplies at depths of 20 to 50 meters (66 to 164 ft.). In La Plana the deeper wells reach water-bearing strata 70 to 80 meters (230 to 263 ft.) below the surface. They penetrate beds of conglomerate, with which are interbedded layers of sand, gravel, and indurated clay.⁶ The deeper wells in some of the piedmont areas, notably those of the Ribera Alta, terminate in limestone, and some of them encounter underground streams flowing in solution channels. A

¹Reference 1, pp. 48-49; Reference 30, Vol. II, Part II.

²Reference 30, I, 379.

³Courtesy of D. Vicente Llinares.

⁴Reference 26, pp. 146-62.

⁵Reference 15, III, 125.

⁶Reference 11D, p. 100.

Nature of Strata	Thickness in Meters
Soil and underlying impervious clay.....	2 to 6
First aquifer.....	6 to 20
Second horizon of impervious deposits.....	8 to 17
Second aquifer.....	3 to 19
Third horizon of impervious deposits.....	9 to 14
Third aquifer.....	1 to 10
Fourth horizon of impervious deposits.....	5 to 10
Fourth aquifer.....	5 to 10
Fifth horizon of impervious deposits.....	5 to ..
Fifth aquifer.....	7 to ..

Fig. 23.--Generalized section of sedimentary deposits in the Huerta de Valencia (Reference 31, VII, 264-65).

very few wells have reached depths of 100 to 150 meters (328 to 492 ft.).¹ In many localities of the Ribera Baja, water bearing sands lie within a few feet of the surface and yield water at low cost for irrigating rice fields. Evidence points to seepage from the Acequia Real del Júcar and from flooded rice fields as the origin of these water supplies.² The deeper stores of water are believed to be renewed by subterranean drainage from the upland in which the Vega streams rise.³ During the last half century these deeper supplies have been made available by scientific methods of prospecting, improved drilling machinery, and the use of mechanical power for pumping.⁴

Because of underground conditions, prospecting for water in the Vega de Valencia is attended by risks similar to those involved in the search for other minerals. This fact is illustrated by the story of a well situated amid the orange groves about a mile east of Alcira. The project was started by the former owner of the land on which the well is located, but his resources were exhausted without striking water. The new owner continued drilling and shortly encountered a copious stream flowing in a limestone channel 60 meters (197 ft.) below the surface. He obtained a contract to furnish the municipal water supply for Alcira, and electric pumps draw a continuous flow of 5,000 liters (176.6 cu. ft.) per minute from the well, with no apparent diminution of the supply.⁵

The pumping equipment in the Vega is of various types. For

¹Courtesy of D. Vicente Llinares.

²Reference 12, I, 190; Courtesy of D. Antonio Lattur Cortés.

³Reference 15, III, 113.

⁴Ibid., pp. 103-5.

⁵Courtesy of D. Vicente Llinares.

drawing water from the deeper wells both piston and centrifugal pumps are employed, but for lifting water from shallow depths the most widespread device is the horse-power noria. The number of norias used in the province of Valencia for irrigation in 1930 was estimated at 4,645.¹ Where modern pumping machinery has been installed, the motive power is furnished principally by electric motors, internal combustion engines, and steam engines. In recent years there has been a shift in the relative importance of the principal sources of power. In 1921, as indicated by a survey covering only part of the province of Valencia, steam engines were more than twice as numerous as electric motors and internal combustion engines combined, supplying power for about two-thirds of the wells considered in the survey.² In 1928 there were, according to an official estimate, 1,900 electric motors used for agricultural purposes in the province of Valencia, 2,100 internal combustion engines, and only 500 steam engines.³ Probably most of these were employed for pumping irrigation water, but the report does not state definitely that this is the case. A similar report for 1930 indicates a small increase in the number of both electric motors and internal combustion engines and a slight decrease in the number of steam engines.⁴ In 1931 an exporter familiar with agricultural practices throughout the Vega summarized the use of power for pumping as follows: "Most orange growers either use Diesel or semi-Diesel engines or else buy commercial current of electricity, which retails at about 0.18 peseta per kilowatt-hour."⁵

The use of ground-water for irrigation involves expenses not faced by landowners receiving water from the long-established canal systems of the Vega. The most important of these are interest on capital investments and power costs for pumping. An estimate was made of these expenses in 1921 by García Ros, chief-engineer of the Valencia District of Mines.⁶ He estimated the capital expenditures (prospecting and drilling, construction of reservoir and pump-shed, purchase and installation of pump and producer-gas engine) for a twenty-meter well in unconsolidated sediments at

¹Reference 26, p. 150.

²Reference 15, III, 139-52.

³Reference 29, p. 23.

⁴Quoted by E. Halpern, Reference 26, p. 150.

⁵Courtesy of D. Vicente Llinares.

⁶Reference 15, III, 125-35.

21,500 pesetas. Computing interest on investment at 5 per cent, and planning for amortization of initial expenditures in 33 years, his formulae show that capital investments impose a charge of 0.017 peseta against each cubic meter of water drawn from a well of this type if the well yields 25 liters of water per second, but that this item of cost per unit volume doubles if the quantity of water is reduced by half. Pumping costs, based on the use of a producer-gas engine consuming anthracite coal, bring the cost of water up to 0.038 peseta per cubic meter for a volume of 25 liters per second, and to 0.054 peseta if the well yields only half that amount. Data furnished by growers' cooperative associations in the early 1920's give for thirty-eight wells in La Plana, with depths of 30 to 50 meters, an average capital investment of 54,276 pesetas.¹ García Ros's formulae give an average cost of 0.087 peseta per cubic meter for water obtained from these wells, which yield an average flow of 20 liters per second.

The depths from which ground-water can be drawn profitably for irrigation varies with the type of crop. It is impossible to compute these depths without detailed statistics regarding the cost of sinking wells of various depths and regarding the usual volume of water encountered at different underground levels. However, it is possible to make some comparisons of specific cases. García Ros estimated the maximum cost at which water could be employed profitably for irrigating typical Vega crops under conditions prevailing in 1921 (Fig. 24). According to these estimates, water from the twenty-meter well considered above could be used

Pesetas per cubic meter	Vega crops for which each cost level is the maximum for profitable utilization
0.02	Rice
0.05	Cereals (except rice), legumes, forage crops
0.07	Onions, early truck crops, early potatoes
0.10	Orchard fruits, oranges on mediocre sites
0.15	Oranges on superior sites

Fig. 24.--Maximum water costs for profitable use in irrigating typical Vega crops (Reference 15, III, 127).

profitably in irrigating any of the principal Vega crops except rice, provided a flow of 25 liters per second were obtained. The high average cost of water from the thirty-eight Castellón wells, on the other hand, would preclude its profitable use except in

¹Reference 11D, p. 281.

the culture of oranges or other orchard fruits. These figures represent comparative, rather than absolute, values, for at the time when the computations were made, farmers in some localities of Alicante and Murcia were paying from 0.60 to 1.00 peseta per cubic meter for irrigation water.¹ In practice, water for irrigating rice in the Vega de Valencia is pumped from depths not exceeding two meters, while water for other cereals is drawn from wells as much as ten meters deep; but most of the deeper wells supply water for orange groves.²

As a means of extending the irrigated area of the Vega through the initiative of individuals or communities, the development of ground-water resources has received much attention in recent years. The increase in the number of wells was marked during the 1920's and continued after 1930. According to official estimates, the number of power pumps used for irrigation in the province of Valencia in 1928 was 3,000,³ and an increase of 200 in the number is said to have taken place within the following two years.⁴ New wells are financed in two ways. In most cases they are established by proprietors of large or medium-sized estates and if the wells yield a surplus the owners may sell water in addition to supplying the irrigation needs of their own land. In some localities, wells have been sunk by cooperative associations, which distribute water to the landholdings of members. This practice is of particular importance in some localities of La Plana where very small landholdings prevail. Of the 38 Castellón wells discussed above, 31 belong to cooperative associations with an average of 51 members per well, the average landholdings of members being a little less than an acre.⁵ Although the cost of a single irrigation from a privately owned well may exceed the annual canal dues for an equal area, the continued increase in the number of wells suggests that the attractions of irrigation from ground-water outweigh its disadvantages. A significant fact regarding the recent expansion of irrigation from wells is that the present generation, like many preceding generations, has contributed to the permanent improvement of the area. Even though particular wells may have been secured at excessive cost, individual loss is balanced against

¹Reference 15, III, 90.

²*Ibid.*, pp. 129-30.

³Reference 29, p. 23.

⁴Reference 26, p. 150.

⁵Reference 11D, pp. 281-82.

benefits for future generations.

Stage of Geographic Development

The characteristic features of occupance in the Vega de Valencia suggest a mature stage of geographic development. Generous returns from agricultural land and the ability to support a large population depend upon the skilful utilization of resources as well as on the nature of the area. Acquaintance with the natural endowment of the locality and skill in the utilization of natural resources accumulated from generation to generation, and gradually the experimental stage of geographic youth merged into the stability of maturity, without loss of flexibility. Among the facts pointing to geographic maturity as the present stage of development, the following are of particular significance: (1) the natural resources of the area have been known and utilized for a long time, details of utilization being modified from time to time according to current needs and technological advances; (2) stream water is distributed under administrative practices conducive to the effective utilization of a scant and fluctuating supply; (3) agriculture operates under techniques that secure large returns from the soil without exhausting its fertility; (4) the effectiveness of soil utilization is furthered by a high degree of areal specialization; (5) balance between local self-sufficiency and commercial intercourse tends toward economic stability; and (6) the occupance pattern has shown areal stability over a long period. While geographic maturity is indicated for the area as a whole, certain localities show characteristics of youth, and geographic rejuvenation is evident in others.

Utilization of available resources.--Throughout a long span of time, occupance of the Vega de Valencia has been characterized by intelligent search for and utilization of available natural resources. Consequently, progress in recent times has consisted in more effective utilization of familiar materials and forces, rather than in the discovery of untouched supplies. Utilization is characterized by a moderation that stops short of exhaustion, hence the same resources appear in the various epochs of development. For the early inhabitants the native animal life of streams and lagoons had vital importance, and the local food supply still includes large quantities of fish from the sea, the Albufera, the shore lagoons, and the rivers. Native vegetation has given way to cultivated crops in most places, but many of the

native species persist and serve various human needs. Pine lumber is obtained from the hilly margins of the Vega, and esparto from certain sections of the Campo de Liria and the area west of the Ribera Alta yields fiber for cordage and coarse textiles. Mineral deposits furnish the principal construction materials for Vega communities now as in the past. Massive stone work, decorative panels of carved alabaster in fine old buildings, roofs of plain tile, and decorated tile used for floors testify to the presence of limestone, gypsum, sand, and potters' clay in the Vega and the neighboring mountains. The prevalence of concretes in recent structures speaks of the same resources, for cement manufacture in Valencia and Castellón gives new flexibility to familiar materials.

From remote ages, agriculture has been of fundamental importance, and the present intensive utilization of the soil is based on regional experience supplemented by the experience of other regions. The use of stream water to transform potential soil value into actual productivity began at least as early as the period of Roman domination, and the present equipment of irrigation facilities retains improvements made at many later periods. The practice of using ground-water for irrigation dates from the introduction of the noria by Moorish invaders,¹ and several thousand norias still are in use to draw irrigation water from depths not exceeding six meters.² The recent expansion of irrigation from wells came when new techniques permitted the tapping of supplies too deep to be accessible previously.

The utilization of water power is widespread and of long standing. Of the 450 developed sites in the basins of the Mijares, Palancia, Turia, Júcar, and Serpis rivers, about 100 are in the Vega or adjacent to its margin.³ The antiquity of power development in the general area is indicated by the nature of the titles under which many power users operate. The title to a developed power site near the source of the Turia goes back to a judicial decision recorded in 1496, and a community in the upper Mijares basin holds a concession dated 1267.⁴ These facts point to a long-established custom of recording titles to power sites, but

¹Reference 11D, p. 277.

²Reference 15, III, 108.

³Reference 40, pp. 810-27, 950-55.

⁴Reference 40, pp. 816-19.

power developments held under prescription rights to which authorities can assign no dates outnumber written concessions. It seems probable that many of the prescription rights go back to Moorish times. Technological advances have given access in the last few decades to power resources outside the local area. Most of the water-power concessions granted since 1890 have been for the generation of electricity, and industries of the Vega are large consumers of power developed in the rugged sections of the upland. Science has given increased command over a long-appreciated resource.

Administration of stream water.--The technique of administering the distribution of stream water has reached a high stage of development in the Vega de Valencia. In fact, the Vega has made a distinctive contribution to the world through the development of community control of irrigation. Outstanding features of the administrative system are: (1) local autonomy in the choice of administrative officers and in formulating the governing ordinances; (2) apportionment of privileges and responsibilities among communities using canal water for domestic needs, irrigators, power-users, and those using water in manufacturing processes; (3) definiteness in the delegation of authority and responsibility to the various canal officials and to individual users of water; (4) canal regulations detailed enough to provide for all the exigencies which centuries of experience have shown to be of probable occurrence; and (5) traditions which make for a sense of responsibility on the part of elected officials and a feeling of respect on the part of the individual members of the irrigation communities.

Valencian procedures in managing the distribution of stream water have won just fame and have served as models for other areas interested in irrigation. Commissioned by the French government in 1816 to study Spanish demesnia and irrigation laws, Baron Jaubert de Passa spent four years in Catalonia and Valencia, visiting the irrigation districts, studying the history of the canal systems, and gaining access to the local records for the purpose of transcribing the governing ordinances.¹ At least two other French studies of large scope were made within the succeed-

¹Jaubert de Passa's work was published in Paris in 1823 under the title Voyage en Espagne dans les années 1816, 1817, 1818, 1819 ou Recherches sur les arrosages, sur les lois et coutumes qui les régissent, sur les lois domaniales et municipales, considérées comme puissant moyen de perfectionner l'agriculture française. The Spanish translation is cited as Reference 30.

ing hundred years.¹ The Italian government also studied the irrigation practices of southeastern Spain, and in the 1880's William H. Hall, California State Engineer, seeking a solution for the problems that were baffling his own state, made an official study of water-resources administration in France, Italy, and Spain.² The Vega de Valencia had much of value to offer these investigators. Brunhes, after an extensive study of irrigation in the Mediterranean Region, characterized the Valencia system as the type of organization par excellence for irrigation in arid lands.³ The merits of this system are reflected at present in the national water-resources policy, for Valencia delegates had an important part in shaping the Spanish Ley de Aguas,⁴ which William H. Hall of California characterized in his report on Irrigation Development as "the most complete and concise water law system" possessed by "any country in the world where irrigation is largely practiced."⁵ That law, passed in 1866, adopted in revised form in 1879, and amended from time to time thereafter, was the first attempt on the part of the national government to secure uniformity throughout the country in the administration of water resources. The section devoted to irrigation reflects a thorough study of the ordinances and traditions governing irrigation practices in the Vega de Valencia. It embodies the following principles which underlie the Valencia ordinances, and which had not been recognized by the Spanish government before that time: (1) the inalienable nature of public ownership of running water, interpreted as implying the power of the nation to concede the use of water, but denying to the holders of water rights the privilege of selling or otherwise alienating any part of the water diverted under their concessions; (2) the right of the public to prevent or punish waste in the use of water; (3) the appurtenance of water

¹Results of these were published as Irrigations du Midi de l'Espagne by Maurice Aymard, and L'Irrigation by Jean Brunhes. The latter is cited as Reference 9.

²Reference 10.

³Reference 9, pp. 427-28.

⁴A Valencia lawyer serving as delegate to the Congreso Nacional de Riegos in 1921 placed on exhibit the original manuscript report of a committee which in 1861, under the chairmanship of his grandfather, prepared the first draft of the national water-resources law. He stated that the recommendations of the committee underwent only slight modification before being incorporated into national law (Reference 15, I, 211 and II, 212).

⁵Reference 10, p. 434.

rights to the land rather than to the individual or corporation holding the concession; (4) the right of landowners organized as irrigation communities to administer the distribution of water in their districts, choosing their own administrative officers, and determining the details of their own administrative procedure; (5) the competent jurisdiction of local irrigation courts in dealing with matters concerning the infringement of canal ordinances; and (6) the obligation of water-power users to turn the water back into the stream below their mills.¹

The Valencia system of water administration is the result of an evolutionary growth extending over at least seven centuries, and probably over a much longer period. Emphasis on the Moorish origin of the canal ordinances commonly obscures the subsequent development of the regulations. The customs inherited from the Moorish period were reduced to writing in connection with Don Jaime's decree giving the irrigators title to the irrigation works.² The system of administration was imperfect at the outset, however, and the ordinances were revised, amended, elaborated, or clarified again and again. The full record of the evolution of the governing institutions exists only in the archives of the individual districts, but Jaubert de Passa made a rather full transcript of the documents relating to one canal of the Turia system. The published collection of ordinances for this district contains amendments made on ten different dates in the 14th century and shows some change or addition to have been made on an average of once in 11 years during the three centuries from 1500 to 1800. The earlier changes, incorporated under monarchs of the Aragonese dynasty, appear as royal orders, which evidently were rulings made to settle controversies appealed to the king. The amendments made after 1500 were executed before a notary by the irrigators and in many cases are introduced by such expressions as "it has been agreed" or "we, the irrigators do ordain and establish."³ Local autonomy and confidence in handling questions concerning irrigation seem to have increased, at least in the Turia delta, during the period of absolutism when even the choice of city and village officials became the business of the central government.

In the Vega de Valencia, to a greater extent than else-

¹Ibid., pp. 552-604.

²Reference 30, I, 141-42, 163-65.

³Ibid., Vols. I and II.

where in Spain, nature and history combined to favor the development of reasoned procedure in the handling of water resources. Under a climate which makes irrigation essential for agricultural success, marked commercial opportunity and an irrigable area large in proportion to water supply make economy in the use of irrigation water advisable; but the arrangement of surface features offers no reservoir sites capable of development by local communities. These conditions are not duplicated in the neighboring areas of the Mediterranean littoral. Catalonia has a somewhat greater rainfall and a more generous supply of stream water, making economy in water utilization less vital. In Alicante and Murcia, with the summer flow of streams even less dependable than in Valencia, nature provided reservoir sites adjacent to the principal alluvial lowlands and capable of development at moderate cost. At an early period, historical trends gave the Vega de Valencia the benefit of irrigation techniques developed in regions more advanced agriculturally at that time than were the lands bordering the western Mediterranean. Lying on the route of the invading Moslem tribes, Valencia had the good fortune, according to the opinion of local scholars, to be settled by agricultural immigrants from Yemen, Hejaz, Syria, and Irak, while the victorious warriors were established elsewhere in the peninsula.¹ Moslem domination of Valencia lasted about 500 years - long enough for ideas brought from older irrigated lands to become rooted and develop along lines suited to the area. The Moslem period was much shorter in Catalonia. The reconquest divided the Mediterranean provinces politically, with resulting contrasts in the trend of water control. The fortunes of war gave Valencia and Catalonia to the Aragonese Don Jaime, whose constructive efforts to build up the agriculture of the conquered territory have elicited much praise. Progress in the handling of irrigation affairs by communities of irrigators was favored by the fact that the greater part of the inner Vega crescent was retained by the Crown instead of being conferred on the nobles who had taken part in the campaigns. During the long struggle of Don Jaime and his successors against the privileged nobles and clergy, whose lands were exempt from taxation, the organized communities of the royal domain repeatedly gained confirmation of their cherished autonomous privileges in

¹Reference 11A, p. 772, n. 7; Reference 11D, p. 275.

exchange for financial support of the monarch.¹ The events of this early period served to fix in Valencia the principles of the public ownership of water and the appurtenance of water rights to the land. In contrast, the more southerly provinces, which fell before the forces of Castile and thus were governed by monarchs interested primarily in the Meseta, allowed these principles to be disregarded; and in later centuries the water supplies fell into the hands of local capitalists and the practice of selling water or irrigation turns became common. In extreme cases, distribution came to be handled through daily auctions of the supply available for the succeeding twenty-four hours.² How the democratic institutions concerned with irrigation in the Vega de Valencia escaped destruction by the despotic central government after the 15th century is not clear. However, the established organization did continue to function, sometimes in defiance of orders from above,³ and the uninterrupted evolution of the Valencia system is one of the fortunate facts of history.

The administration of irrigation in the Vega de Valencia at the present time faces conditions that will test anew the adaptability of its institutions. Provision of storage has begun, bringing with it new problems. Fortunately for the Vega, storage of water for irrigation was delayed until the principles underlying its administrative practices had become firmly fixed in local regulations and local traditions and had been incorporated into national law. The experiences of other sections of Spain suggest that the provision of storage at an earlier time through the aid of private capital probably would have been attended by unfortunate circumstances. Brunhes found that in every Spanish irrigation district provided with storage reservoirs the community administration of distribution had been disrupted, the control of the stored water had fallen into the hands of capitalists, and the small landowners had lost a good deal of their independence. Controversies had become numerous and there had grown up a confusion of practices out of which the local communities never had succeeded in building an orderly system. His research convinced him that the unfortunate conditions were due to the construction

¹Reference 11B, I, 362-430.

²Reference 9, pp. 95-108; Reference 10, pp. 414-32.

³Reference 15, II, 317-18.

of expensive reservoirs without considering the existing economic and administrative organization of the area to be served.¹ Within the Vega itself, the extension of the Acequia Real del Júcar in the 18th century through the investment of private funds resulted in a long succession of controversies and the intervention of the national government in canal administration, besides establishing a perpetual tribute to be paid to the builder or his heirs.² The present water law aims to prevent the builders of irrigation works from gaining undue power over users of water. It recognizes stored water as belonging to the public domain and recognizes participation in the conservation of water resources as a duty of the national government. It provides that concessions to individuals or companies planning to distribute water to the property of others shall be temporary, the period not to exceed 99 years; and that the distribution of water from the reservoirs shall be administered by organized communities of irrigators, ownership of the irrigation works passing to these communities at the expiration of the concession period.³ Legislation on this subject was facilitated by the fact that the Vega de Valencia furnished the national government with an example of the successful administration of irrigation by communities of water users.

Technique for conserving soil fertility.--A tendency to consider the future results of present acts belongs to a mature stage of development. Agriculture being vital to the life of the Vega, the conservation of soil fertility receives serious consideration and has done so for a long time. Present practices are based on regional experience extending over centuries and on scientific discoveries of more recent times.

Before the end of the 18th century the technique of soil conservation had reached an advanced stage of development. Crop rotation on irrigated land and the customary use of fertilizer point to sharp contrasts between Valencian agriculture and that practiced at the same time in many American areas then in early geographic youth. Even at that early time the demand for barnyard manure exceeded the supply and farmers made up the deficiency by using whatever substitutes they could secure. The beneficial effects of legumes on the soil were familiar, the culture of alfalfa

¹Reference 9, pp. 95-108, 427-29.

²Reference 30, I, 440-68.

³"Agua," Reference 20.

was widespread, and the use of habas for green fertilizer was common.¹ The other available materials differed from one section to another, including the following: waste from the trays where silk-worms were fed; seaweed thrown up on the shore by waves; rushes and other aquatic plants from the Albufera and smaller lagoons; sweepings from roads and city streets; friable marl broken up and left on the fields for several months before being plowed in; and the slimy mud furnished by the periodic cleaning of irrigation canals and city sewers.² In the late 1700's and early 1800's it was customary for farmers to sweep the city streets and pay for the privilege of doing so. The streets were surfaced with gravel from the bed of the Turia, and because this material consisted largely of limestone fragments, traffic quickly reduced it to dust. For each load of the resulting mineral and organic mixture which the farmers removed, their contracts required them to haul a load of fresh gravel and spread it on the streets. They collected fertilizer from the highways with equal diligence, but there seem to have been no regulations requiring them to restore the surface of the roads. Farmers also hauled away the refuse from the city market each night for use on their fields as fertilizer.³ At two meetings of the Valencia Sociedad Económica de Amigos del País in 1788, papers were presented on the subject of fertilizers, one paper dealing with manure from city streets, its value for the fields and its harmful effects in the city. Thereafter, papers on fertilizer problems were presented nearly every year.⁴

Progress in fertilizer practice during the past hundred years is based on the growth of soil science and increasing commercial intercourse between regions, but the benefits of local experience have been retained. About the middle of the nineteenth century, commerce alleviated to some degree the shortage of fertilizer materials. Valencia was an early user of guano, the earliest shipments of which arrived in 1844.⁵ This commodity now has been superseded by chemical fertilizers, the annual consumption of which in the province of Valencia is estimated at 150,000

¹Reference 12, I, 56, 107, 119, 133, 140, 175, 198, 232.

²Reference 12, I, 133, 159, 169, 189, 208; *ibid.*, II, 130, 149, 209.

³Reference 30, I, 507; Reference 12, I, 133, 159.

⁴Reference 16, p. 327.

⁵Reference 28, p. 15.

tons.¹ Chemical fertilizers have not displaced, but rather supplement, organic fertilizers of local origin. A local authority estimates that 2,000,000 tons of barnyard manure, tannery and slaughter-house waste, and city garbage are used annually for fertilizer in the province of Valencia.² A similar amount of organic material is added to the soil annually by habas grown for green fertilizer. The twelve Valencia factories which produce chemical fertilizers depend upon other areas for most of their raw materials. Spanish pyrite, delivered by coasting vessels, is roasted to secure sulphuric acid for treating foreign phosphate rock. Local plants produced in 1928 about fifteen times as much superphosphate as was imported through the port of Valencia. Nitrates are imported both from the European Manufacturing Belt and from Chile, and small quantities of ammonium sulphate are produced locally in connection with coke manufacture at the Sagunto iron and steel plant. Potash is used sparingly, constituting only about 6 per cent of the chemical fertilizer materials employed. This fact is attributed to relative prices and to the high potash content of Vega soils. Spanish potash, the production of which increased rapidly after 1925, was quoted in 1928 at prices slightly below those of the imported product, and in the following year nearly 5,000 tons of potash minerals were delivered by coasting vessels at Valencia and Gandía, an amount slightly greater than the 1928 potash imports of these ports.³

Areal specialization.--The geoponic pattern of the Vega de Valencia denotes a degree of areal specialization commensurate with geographic maturity. The areal differentiation associated with the development of the geoponic types (Fig. 9) results in increased utility of contrasted types of terrain and at the same time makes for diversity of production. Scant historical evidence suggests that the types emerged at different times within a long evolutionary period, their emergence marking steps in comprehending the possibilities of the area, and their development indicating acquaintance with an increasing variety of crops. Both the forces of nature and the activities of mankind have participated in the evolutionary changes. Occupance extends back over so long a period that physiographic processes have made notable additions

¹Ibid., p. 20.

²Ibid., p. 7.

³Ibid., pp. 20, 26; Reference 42, 1928, p. 139; Reference 46, 1928, pp. 242-243, 468; Ibid., 1929, pp. 372, 690, 702.

to the arable area within the human period, and man's work has hastened the change in some localities. Progress in the utilization of resources also reflects the migrations of peoples, for successive waves of population have contributed to the evolutionary growth. According to a Spanish saying, nature provided the physical basis for agricultural development, and upon this foundation the inhabitants of the Vega have created the vineyards, the huertas, the rice fields, and the orange groves. The diversity thus attained contributes to economic stability, and the diversity is augmented by further specialization of an areal nature within the units of a single type. Because of extreme diversity in agricultural production, the landscape holds many possibilities of alternative procedures in the event of interruptions to established lines of trade.

Diversity of economic motive.--A balance between local self-sufficiency and commercial intercourse with other regions gives an economic flexibility that is akin to the resourcefulness of maturity. Production for export is emphasized, but in most of the export lines the sales to domestic markets exceed shipments to foreign countries. Production for domestic markets is concerned with commodities having nation-wide distribution and with many others destined for local consumption. The stabilizing effect of such diversity is suggested by a comparison of the trade of Valencia with that of other Spanish ports during a period which covers the beginning of the present world depression (Fig. 25). The tonnage of inbound and outbound cargo (coastwise and

Year	All Ports		Valencia	
	Thousand Tons	Per cent Increase	Thousand Tons	Per cent Increase
1926	23,306	..	1,521	..
1927	29,768	28	1,621	7
1928	29,537	- 1	1,781	10
1929	31,084	5	1,935	9
1930	29,750	- 4	1,923	- 1
1931	22,909	-23	1,576	-13

Fig. 25.--Effect of world depression on port business. Combined outbound and inbound tonnage of cargo handled at Valencia and total for all Spanish ports, foreign and coastwise trade considered together, 1926-1931 (Computed from data in Reference 42, 1928, 1929, 1931, and Reference 46, 1929, pp. 40-41, 76-77, 106-7, 130-31).

foreign trade combined) handled at the port of Valencia in 1929 exceeds the amount handled in 1926 by 27 per cent, but the total for all Spanish ports showed an increase of 33 per cent in the same period. In 1931 the effects of the depression forced the total trade of all Spanish ports down to 80 per cent of the average for the preceding five years but caused a drop of only 10 per cent in the corresponding figure for Valencia. In contrast, the tonnage handled at Bilbao, with its highly specialized trade, shows fluctuations greater than the average for all ports, rising in 1929 to 150 per cent of the 1926 volume, and falling in 1931 to 35 per cent of the five-year average.¹

The economic diversity of the Vega de Valencia recalls the fact that human occupance in this area dates from an age when commerce had little importance as a world phenomenon. Agriculture is dominantly commercial, but vast numbers of small tracts are devoted to supply crops. The scope of production in field and factory is broad enough to touch a large proportion of human needs, for the area in geographic maturity retains many features which distinguished it in the days of local self-sufficiency. Mineral industries contribute in essential ways to life in the area and furnish minor export products. Small factories are numerous and produce a diversified output, many of them having been established long ago to supply local needs. With the growth of world commerce, many interests of Vega people have shifted in relative importance. Thus the production of textile fibers and the manufacture of textile fabrics, essential to life in the era of local self-sufficiency, now have been relegated to minor rank. Orange culture, in contrast, has risen to major importance under the stimulus of foreign commerce.

The economic diversity of the Vega shows, as one of its characteristics, rather complex interrelations among the industries of the area. This fact is illustrated by the ramifications of interests related to the fruit and vegetable trade. A number of sawmills cut lumber into the sizes used in making shipping crates for oranges and onions, and numerous cooperages make casks for wine and olive oil. Several important paper mills in the Vega specialize in the manufacture of tissue paper for wrapping oranges, their paper stock being derived principally from local materials,

¹Computed from data in Reference 42, 1928, 1929, 1931.

such as waste paper, rags, old shipping bags, and worn-out alpargatas (the canvas shoes with hemp soles almost universally worn by peasantry and workmen during the summer). Complete equipment for this type of paper mill is made in a small town near the southern margin of the Vega.¹ For this industry, and also for the local manufacture of agricultural implements and machinery, the Sagunto iron and steel plant offers a local supply of raw material. Transportation to market or to point of export accounts for another industry related to the fruit and vegetable trade. Produce is hauled principally by individuals or companies engaged in transportation and employing either motor trucks or horse-drawn carts; and the transportation industry, in turn, provides a market for alfalfa grown near the commercial centers. Another related interest is the preparation of fruit products. The preparation of juice, both "natural" and concentrated, absorbs much of the surplus of the orange crop, together with undersized or slightly damaged fruit unfit for export. Associated with the juice industry is the extraction of the essential oil of orange, which forms the base for perfumes. This by-product of the citrus industry is utilized in the manufacture of perfumes by a dozen Valencian firms, and its annual export volume averaged 109 tons in the two-year period 1928-29. Canning and the preparation of marmalade and other conservas also consume important quantities of agricultural produce, amounting in the case of tomatoes to an estimated 30 per cent of the crop.

Diversity of economic interests in the Vega results from several groups of causes. In some of its phases it reflects the natural diversity of the area. In others, it has been accomplished through the adoption of modern ideas and the introduction of new industries. In still other phases, it exists because certain industries have persisted from the past, though their importance at present is not great. These industries, inherited from the era of local self-sufficiency, have potential significance for economic stability in the event of interruptions to the established flow of commerce.

Stability of occupation pattern.--Further evidence of geographic maturity is found in the fact that recent adjustments of

¹Spain, Ministerio de Industria y Comercio, Sección de Propaganda: Información Comercial Española, November, 1933, pp. 336-339.

the established occupance pattern have been of a minor nature. New towns are rare, and bills of rights granted by the victorious Don Jaime I at the close of the Moorish regime establish a venerable age for most of the towns and villages incorporated as heads of municipal términos.¹ The list of about 200 such Vega communities for which data are given in recent census volumes includes only three names not mentioned by Cavanilles in the report of his survey made in the early 1790's.² A comparison of the present distribution of agricultural types with that described by Cavanilles shows striking similarities. The pattern of trails and highways as mapped by Cavanilles bears remarkable resemblance to the transportation pattern of today, though a railweb has been established and the network of improved roads has become denser.³ That contact with the Mediterranean long has been made at the sites of the present ports is indicated by the retention of the term grao (meaning a beach where boats load and discharge cargoes) at these ports to designate the harbor, together with its equipment and the contiguous commercial suburbs.⁴ This stability in the location of community centers and of facilities for the flow of trade indicates a workable degree of harmony between the cultural pattern and the distribution of natural features and resources.

A satisfactory balance between the number of inhabitants and the productive resources is indicated by the absence of any strong tendency toward migration out of or into the area. Contrasts in facial characteristics between Valencians and the people of the Meseta argue against an active interchange of population between the two sections in the past, as does also the persistence of the hereditary Valencian language. Evidence against the existence of any great shifting of population through migration in recent years is furnished by census data. Two per cent of the people having residence rights (población de derecho) in the province of Valencia were absent at the time of the census enumeration in 1920, and people not considered residents (transeúntes) made up 1 per cent of the total population. The corresponding percentages for Spain are 5 and 2 respectively.⁵ The shifting of population

¹Reference 11B, Vols. I and II; Reference 11C; Reference 11D.

²Reference 12, II, 315-21; Reference 38, 1930.

³Reference 12, Vol. I, map facing p. 236; Map Reference 5.

⁴Reference 11B, I, 867. ⁵Reference 42, 1928, p. 14.

by over-sea migration has been proportionally less, at least in recent years, than the average for Spain (Fig. 26). In the five-

Year	Total Shift (Emigration plus Immigration)		Net Gain	
	Spain	Valencia	Spain	Valencia
1925	438	108	- 83	18
1926	399	114	- 25	16
1927	400	106	- 11	29
1928	408	96	- 47	5
1929	407	96	- 64	5
1930	390	88	0	9
1931	320	78	186	8

Fig. 26.--Recent shifting of population by over-sea migration (Computed from data in Reference 42, 1931, pp. 36-46). Figures are ratios per 100,000 inhabitants, computations based on population according to 1920 census.

year period 1925-29 the net effect of over-sea migrations was a loss for Spain of 230 inhabitants per 100,000 of total population and a gain of 73 per 100,000 for Valencia. The change in trend after 1929 obviously is associated with the world depression, for the immigrants reported are altogether returning Spanish nationals, approximately half of whom had been away for more than five years. That most of the immigrants went to their old homes is suggested by the fact that the influx was exceptionally great in the provinces which, like those of Galicia, had contributed largely to the emigrant stream of previous years.

Continued growth in population capacity shows that the stability of maturity has not passed into the stagnation of old age. Cavanilles reported widespread conditions of poverty and privation in the provinces of Valencia, Castellón, and Alicante, giving the impression that at the end of the 18th century the population was pressing hard upon the productive capacity of the land.¹ The 1930 census shows an increase of 131 per cent over the estimate for 1794, but the slight importance of emigration in recent years suggests that in spite of this increase the area is not overcrowded at present. Furthermore, the Vega in the summer of 1931 gave the impression of having, on the whole, a busy and

¹Reference 12, I, xi.

contented population; and recent descriptions written by people well acquainted with local conditions portray a fair degree of prosperity. These facts indicate an increase in productive capacity even greater than the increase in population, thus furnishing conclusive evidence that the area has not reached geographic old age.

The irregular rate of population growth as revealed by census returns suggests the influence of certain developments that gave added control over familiar resources or greater opportunity for trade by sea. A marked contrast exists between the rate of increase from 1794 to 1860 and that occurring in the succeeding six decades (Fig. 27). Between 1860 and 1920 the population of the Vega increased 57 per cent, in contrast to an increase of 29 per cent during the 66 years from 1794 to 1860. The

Census Year	Maritime Division		Middle Division		Total Vega	
	Population	Per cent Increase	Population	Per cent Increase	Population	Per cent Increase
1794	372,859	..	111,040	..	483,899	..
1860	472,136	27	154,131	39	626,899	29
1877	540,125	14	161,747	5	701,872	12
1887	608,376	13	173,007	7	781,383	11
1900	686,934	13	182,967	6	869,901	11
1910	763,995	11	182,559	-0.2	946,554	9
1920	800,203	5	183,367	0.4	983,570	4
1930	929,510	16	186,155	1.5	1,115,665	13

Fig. 27.--Population growth of the Vega de Valencia (Computed from data in the following sources: Cavanilles' estimate for 1794, Reference 12, II, 315-21; other years, Reference 38, 1860, 1877, 1887, 1920, 1930). Population figures are for the secondary census units (judicial divisions) which lie wholly or partly within the Vega. Thus considerable areas lying outside the Vega are included, particularly in the Middle Division.

accelerated rate of population growth beginning about the middle of the century accompanied a group of circumstances which, together with their effects on the population capacity of the area, may be interpreted as geographic rejuvenation. Imported guano to some degree was alleviating the fertilizer shortage that previously had restricted the productive capacity of the land. The Industrial Revolution had got well under way and commerce in staple foodstuffs was becoming a major world phenomenon. Speedier ocean transportation permitted perishable food products to gain

a more important place among the commodities of trade. French and British purchases of Spanish oranges were increasing at a rapid rate by the middle of the century,¹ and in the early 1860's the fresh fruit exports of Spain had an average value a third as great as that of the dried fruits exported.² Growing commercial opportunity led to a wave of expansion in the orange acreage at about this time, undoubtedly involving an expansion of the irrigated area through the use of ground-water drawn by norias from newly established wells. About the end of the third quarter of the century new techniques gave access to deeper supplies of ground-water, thus permitting another expansion of the irrigated area. The demand for fresh fruits and other perishable food products in world markets increased still further. The cultivation of the vine became more profitable because of the wine shortage resulting from the phylloxera disaster in France, and a notable expansion of the vineyard acreage took place.³ The declining rate of population growth from 1887 through the second decade of the present century is in harmony with the concepts of an area in geographic maturity, but the abrupt change in trend during the 1920's (Fig. 27) suggests a further increase in productive capacity. This decade was marked by a rapid growth in the volume and variety of Vega commerce and by notable additions to the irrigated acreage through the sinking of wells, with minor additions resulting from the provision of water storage. The significance of irrigation and sea-borne trade in the increased population capacity of the Vega is emphasized by the contrast between the Maritime and Middle divisions in rate of population growth during the seven decades from 1860 to 1930.

¹Based on the following sources: France, Direction Générale des Douanes, Tableau décennal du commerce de la France, 1826-36 and later volumes; Great Britain, Annual Statement of the Trade and Navigation of the United Kingdom, 1854 and later volumes.

²Reference 42, 1866-67.

³Reference 11A, p. 774, n. 14.

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A. Reino de Valencia (sub-title). Pp. 1,008.

A general treatment by various authors, dealing with the area making up the former kingdom of Valencia. This area now consists of three provinces, namely, Valencia, Alicante, and Castellón de la Plana. The following divisions are included: Physical geography, Geology and paleontology, Fauna, The Valencian language, Agriculture, and Archeology and art. (There is internal evidence that the writing was in progress in 1921.)

B. Provincia de Valencia. 2 vols.

Vol. I, by José Martínez Alcoy. Pp. 1,091. This volume includes a general description of the province and a detailed treatment of the city of Valencia and the area under its municipal government. Some 200 pages are devoted to a treatment of historical events which centered about Valencia as a capital, giving special attention to the relations between the people and their rulers, and showing scholarly research in the rich store of information in the local archives. Every community in the judicial division of Valencia is treated in detail. (There is internal evidence that work on this volume had begun before 1918 and that it was not finished before 1924.)

Vol. II, by Carlos Sarthou y Carreres and José Martínez Alcoy. Pp. 1,022. This volume considers every community of the province outside the judicial division of Valencia.

C. Provincia de Alicante, by Francisco Figueras Pacheco. Pp. 1,206.

This volume gives a general survey of the province under the following divisions: Physical features, Historical sketch, Population, Resources, and Organization. Then follows a detailed treatment of each community in the province.

D. Provincia de Castellón, by Carlos Sarthou y Carreres. Pp. 1,088.

General structure similar to that of volumes dealing

with other provinces. The portion treating the province as a whole contains the following divisions: Geographic and physical description, Historical sketch, Administrative geography.

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A scientist with special interest in botany, Cavanilles was sent by the king to make a survey of the natural vegetation of the three provinces commonly grouped together under the title Kingdom of Valencia. He decided, on his own responsibility, that a survey would be more valuable if it touched other features besides the vegetation. He visited every community of the three provinces, taking about three years for his survey. He secured population estimates for all communities, talked with the people, praised or criticized their agricultural methods, obtained estimates of cultivated areas and crop returns, estimated elevations and described geological formations, and drew a new relief map of the area. He did such an admirable piece of work that he has been quoted over and over by later writers.

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The pamphlet on rice was prepared specially for use on May 15, 1926. At that time the author was at the head of the rice experiment station at Sueca.
22. Font de Mora, Rafael. El naranjo, su cultivo y explotación. Madrid, 1922.

At the time this book was written the author was on the instructional staff of the provincial experiment station and agricultural school at Burjasot, three or four miles northwest of Valencia.
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36. Spain, Dirección General de Agricultura. Anuario estadístico de las producciones agrícolas. Madrid, annual publication of which only a few numbers seem to have been issued.

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39. Spain, Dirección General de los Registros Civil y de la Propiedad y del Notariado. Estadística del registro de la propiedad, 1871, 1872, 1873. Madrid, 1881.

Statistics by provinces, judicial divisions, and municipal términos of changes in property titles, classified as urban and rural, also of property titles recorded for the first time. Areas and values of properties are given.

40. Spain, Dirección General de Obras Públicas. Estadística de las obras públicas de España - Obras hidráulicas, situación en 1º de Enero de 1917 y datos correspondientes a los años 1909, 1910, 1911, 1912, 1913, 1914, 1915, y 1916. Madrid, 1921. Pp. 1,275.

Among the types of data included in this volume are stream measurements, rainfall records, concessions for irrigation from streams, concessions for the development of water power, use of streams for floating logs, and concessions for industrial use of stream water.

41. Spain, Observatorio Central Meteorológico de Madrid. Resumen de las observaciones efectuadas en las estaciones del Servicio Meteorológico Español.

Fully equipped meteorological stations are maintained only at the provincial capitals, but for about twenty years a large number of co-operating stations have kept rainfall records. However, the records of nearly all the co-operating stations show many breaks.

42. Spain, Servicio General de Estadística. Anuario estadístico de España. Madrid, published annually.

43. Streil and Walter. "Bericht über eine im September-Oktober 1927 ausgeführte Reise nach Spanien zum Studium des Weinbaues," Berichte über Landwirtschaft, Zeitschrift für Agrarpolitik und internationale Landwirtschaft, Neue Folge, Achtes Sonderheft, pp. 1-36. Berlin, 1928.

44. Valencia, Cámara Oficial Agrícola de la Provincia de Valencia. Cartilla vinícola y métodos analíticos para uso de los alumnos de los Cursos Breves de Enología. Valencia, 1926.

Pamphlet of 127 pages prepared for the use of students in the annual short courses in wine-making offered in Valencia. Part I, pp. 7-80, contains a simplified presentation of the theory and practice of wine-making and blending, by Rafael Janini Janini. Part II, by Valentín García Tena, chemical specialist in the Estación de Viticultura y Enología in Requena, Valencia, presents the methods of analyzing wine and its by-products used in the experiment station work. The pamphlet was prepared as a summary of the short courses and intended to aid the students' memory after they had returned to the practical work of vinification.

45. Valencia, Cámara Oficial de Comercio, Industria y Navegación de Valencia. Boletín.

Monthly publication carrying economic and commercial news items and giving export and import statistics for the port of Valencia.

46. Valencia, Cámara Oficial de Comercio, Industria y Navegación de Valencia. Memoria sobre el estado de los negocios y el movimiento comercial e industrial de la provincia. Valencia, annual publication.

Gives detailed statistics of foreign trade at each port of the province, and for 1928 and 1929 gives similar data for coastwise trade. Gives summaries of rail loadings; also agricultural statistics.

47. Vilanova y Piera, Juan. Memoria geognóstica-agrícola y proto-histórica de Valencia. Madrid, 1893.

While primarily a geological study, Vilanova's work considers the significance of geological conditions for the human utility of the area.

48. Vilanova y Piera, Juan. "Memoria geognóstica-agrícola sobre la provincia de Castellón," Memoria de la Real Academia

de Ciencias de Madrid, 3a series, Ciencias Naturales, Vol. II, pp. 575-800. Madrid, 1856.

49. La Voz del Comercio.

A periodical published monthly or semi-monthly in Valencia and devoted to the interests of foreign trade in agricultural products, particularly the fruit and vegetable trade.

MAPS

1. Martin, Alberto (ed.). Mapa de la provincia de Alicante. Scale 1 : 250,000. Barcelona, not dated.

Colored map showing judicial divisions but not showing boundaries of municipal términos. Incorporated towns and villages are shown, also railroads and main highways. Mountains indicated by shading. Carries census data for 1910.

2. Martin, Alberto (ed.). Mapa de la provincia de Valencia. Scale 1 : 250,000. Barcelona, not dated.

Similar to the Alicante map, but gives boundaries of municipal términos as well as those of judicial divisions. Carries census data for 1910.

3. Martin, Alberto (ed.). Provincias de España. Valencia. Scale about 7 miles to the inch. Barcelona, not dated.

The map is declared to be based on data furnished by the Instituto Geográfico y Estadístico, but it gives evidence of being constructed on an old base. An accompanying pamphlet of 12 pages gives altitudes determined at marked points along three major highways.

4. Michelin & Cie. (eds.). Mapa Michelin de España. Scale 1 : 400,000. Clermont-Ferrand, France, not dated.

These road maps seem to be prepared with care and to be more nearly accurate than most of the available maps of the Valencia area.

5. Muga, Emeterio. Mapa-itinerario de las provincias de Castellón de la Plana, Valencia y Alicante. Scale 1 : 300,000.

Based on data published by departments of the national government and on field observations made by Captain Muga. Published in Valencia, originally in 1909, but the transportation pattern was corrected to 1927.

The map shows trails as well as railroads and improved highways. It was awarded a diploma of honor and a gold medal at the Exposición Regional Valenciana in 1909.

6. Spain, Dirección General del Instituto Geográfico y Catastral. Planos de términos municipales. Scale 1 : 25,000.

